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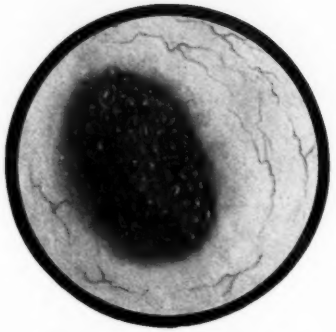
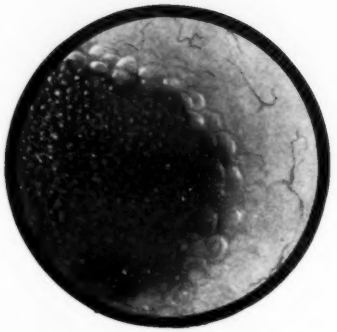
Case 1. A tuberculoma surrounding and occluding the left ureteral orifice in a case of left renal tuberculosis. The remainder of the bladder was essentially normal.



Case 2. An inflammatory reaction in the wall of the bladder secondary to a contiguous tuberculous inflammation of the remaining portion of the adnexa uteri.



Case 3. The left margin of an extensive inflammatory reaction in the wall of the bladder secondary to an adherent inflamed left tube and ovary (probably tuberculous).

Inflammatory Lesions of the Bladder Simulating Neoplasm.—J. J. Joelson and W. E. Lower.

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INFLAMMATORY LESIONS OF THE BLADDER SIMULATING NEOPLASM

REPORT OF THREE CASES

BY J. J. JOELSON, M.D., AND W. E. LOWER, M.D., F.A.C.S., CLEVELAND, OHIO
From the Department of Surgery, Western Reserve University School of Medicine and Lakeside Hospital.

INFLAMMATORY lesions of the bladder which closely simulate true neoplasm are not common. Generalized inflammation, whether of the type of proliferative cystitis or bullous œdema, or the reaction about the orifice of a vesical diverticulum or a vesico-intestinal fistula, presents a distinct condition usually recognizable by cystoscopy. The discrete inflammatory lesion as exemplified in the following case reports seems to offer so few differential signs from true tumor that it deserves further study. Those cases already reported emphasize the great difficulty of diagnosis. Cystoscopy presents few specific signs, and many of the cases heretofore reported have been diagnosed as neoplasm. Roth (11) mentions briefly a vegetative process occurring in tuberculous bladders "which simulates villous or papillomatous growths so closely as possibly to cause some confusion." Latchem (9) makes a similar statement. Many other writers have described areas of granulation tissue occurring in tuberculous bladders (4, 5, 6, 7, 10). Thomas (12) reports a non-tuberculous granuloma of the bladder. Kielleuthner (8) reports two cases in which he diagnosed the inflammatory reactions at the mouths of diverticula as carcinomata. Syphilitic tumors of the bladder also occur (2, 3, 8).

Cimino (1) recently has reported five cases of inflammatory tumors of the bladder. He divides these lesions into two classes: viz., (a) inflammatory tumors of the wall of the bladder (ligneous phlegmons), and (b) inflammatory tumors extending into the cavity of the bladder. Three of his cases were of the former type, and since this lesion is apparently quite different from the localized inflammatory tumor of the bladder, these cases need not be discussed. His other two cases, however, were of the latter type and may be briefly summarized as follows.

One occurred in a woman 76 years of age who, following divulsion of an anal fissure, began to have strangury, frequent and painful desire to urinate, false incontinence, and lancinating pain in the bladder. The urine, which was at first purulent, became greenish, stringy, and putrid. There was also hæmaturia. On vaginal examination, a mass could be felt in the bladder. Cystoscopic examination showed a sessile, grayish rose colored tumor, the size of a large almond. It had a fleshy appearance. Its surface was granular and covered in spots with purulent fibrinous shreds. The tumor had a large base situated on the trigone and was raised about 3 centimeters above the mucosa. The diagnosis of carcinoma of the bladder was made and, because of the patient's age, the condition was considered inoperable. With local treatment, however, the patient improved rapidly. Another cystoscopic examination, made 4 months later, showed that the tumor had entirely disappeared, and in its place there was only

a slight irregular wrinkling of the hyperplastic and hyperæmic mucosa.

The other case occurred in a soldier 23 years of age. This patient apparently had received a penetrating wound of the bladder 2 years previously. Urine drained from this wound several months before it healed, but since that time he had noticed terminal hæmaturia. Cystoscopic examination showed a rose colored tumor on the left lateral wall which resembled a mulberry. The surface of the tumor was covered in some small areas by a grayish membrane, and some bleeding points were also present. Roentgenograms showed the metal bullet to be extravesical. The patient refused operation but returned one year later in the same condition. The cystoscopic appearance of the tumor was unchanged. At operation the tumor was grasped with forceps and as a result of this it separated close to its base. The base of the tumor which remained attached to the wall of the bladder contained a small bit of woolen cloth. The histological examination of the tumor showed a "chronic inflammatory process from the presence of a foreign body."

We have three cases to report. They illustrate well the difficulty in diagnosis, but at the same time they emphasize points which if duly considered should assist in making an accurate diagnosis. We ourselves benefited to such a degree from Case 1 that we were able to appreciate the true condition in Case 2, though we again failed in Case 3. The operation in Case 3, however, was probably necessary since the removal of infected material lying against the bladder relieved the condition permanently.

Case 1. A married Austrian woman, 30 years of age, came to the hospital because of frequency and dysuria.

Her past history was unimportant except for the following fact: seven years ago she had chills and fever following a stillbirth, and one year later both ovaries and tubes were removed.[1]

The present illness had a gradual onset about one year before admission to the hospital. It started with frequency, nocturia, and burning on urination. These symptoms steadily increased in severity. At no time did she notice hæmaturia or cloudy urine.

For several weeks prior to her admission, the patient was observed in the gynecological dispensary. In this department repeated urinalyses at no time showed pus cells or other abnormal urinary constituents. A cystoscopic examination done in the dispensary showed a tumor in the region of the left ureteral orifice.

Upon admission to the urological service the physical examination was negative except that the patient was pale and thin.

[1] No report available—probably pelvic inflammatory disease.

Laboratory findings: blood Wassermann, negative; hæmoglobin, 80 per cent; leucocyte count, 6,700; urine, yellow, clear, acid; specific gravity, 1010; albumin, 0; sugar, 0. Microscopic examination showed a few white blood cells, no red blood cells, no casts. Cultures made from urine from bladder were sterile.

Roentgenograms of the urinary tract showed no shadows of increased density. The outlines of both kidneys were plainly visualized. The right appeared normal, but the left showed a marked irregularity consisting of a deep notch in the convex border of the kidney.

Cystoscopic examination showed that the vesical capacity and tone were normal. In the region of the left ureteral orifice there was seen a reddish tumor which was about 1.5 centimeters in diameter and raised about 1 centimeter above the surrounding mucosa. The tumor was sessile and its surface presented numerous rounded villi. No ulceration was present. The left ureteral orifice could not be located. The remainder of the bladder was essentially normal. The right ureteral orifice was normal.

In view of the sessile character of the tumor, a diagnosis of carcinoma of the bladder was made, and a suprapubic cystotomy was performed. After opening the bladder the lesion was palpated and was found to be very firm. The tumor, its surrounding mucosa, and a part of the intramural portion of the ureter were excised. The cut edges of the vesical mucosa were loosely approximated and the wound was closed in the usual way. The patient made an uneventful recovery.

Pathological report. The specimen consisted of a piece of tissue 2.0 by 1.8 by 1.2 centimeters. It was firmly elastic in consistency. Histological examination showed one margin of the section covered with stratified vesical epithelium which overlay a fibrous connective tissue stroma. The stroma was extensively infiltrated with small lymphocytes and a few plasma cells and polymorphonuclear leucocytes. Many typical tubercles with giant cell formation were scattered throughout the tissue (Figs. 1 and 2).

Nine days after the operation, because of the histological diagnosis of tuberculosis, another cystoscopic examination was made. The urine from the bladder was now turbid with pus, and a fairly marked degree of generalized cystitis was present. In the region of the left ureteral orifice, the previous site of the tumor, a wide, deep wound was seen. Some sloughing tissue was attached to the edges of this wound and a moderate degree of bullous œdema surrounded it. The left ureteral orifice could not be located. The right orifice appeared normal and was easily catheterized. The urine from the right kidney was grossly clear and microscopically negative. One cubic centimeter of phenolsulphonephthalein was injected intravenously. It appeared in the urine from the right kidney in 2 minutes, and *40 per cent* was excreted in 15 minutes.

Four days later another cystoscopic examination was made, and indigocarmine was injected intra-

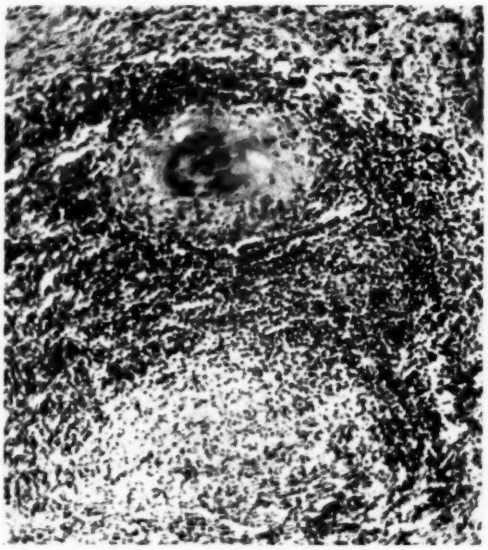

Fig. 1. Photomicrograph showing a typical tubercle with giant cell formation in the vesical wall. × 150.

muscularly. The dye could be seen in the urine coming from the right ureteral orifice 10 minutes after its injection. On the left side, however, the ureteral orifice could not be located since no dye could be seen coming from this region, although it was carefully sought for 30 minutes.

The patient was discharged 3 weeks after operation. During the following 2 months she continued to have frequency, nocturia, and persistent pyuria. She was then admitted to the hospital for another complete urological examination.

Cystoscopic examination this time revealed a depressed scar in the region of the left ureteral orifice. This was completely epithelized and apparently marked the site from which the tumor had been excised. The left ureteral orifice appeared as a patulous opening at the bottom of this depression. Both ureters were catheterized. A definite but passable obstruction was met 1 centimeter above the left ureteral orifice. A normal intermittent flow was obtained from both kidneys. The urine from the right side was grossly clear and microscopically negative. A careful search for tubercle bacilli in this urine did not reveal any acid-fast organisms. The urine from the left kidney was grossly turbid and microscopically showed many pus cells. Numerous tubercle bacilli were found in the sediment of this urine. One cubic centimeter of phenolsulphonephthalein was injected intravenously. It appeared from the right kidney in 3 minutes, and 32 per cent was excreted in 15 minutes. The time of appearance on the left side was 4 minutes, but this kidney excreted only 5 per cent of the dye in 15 minutes. A

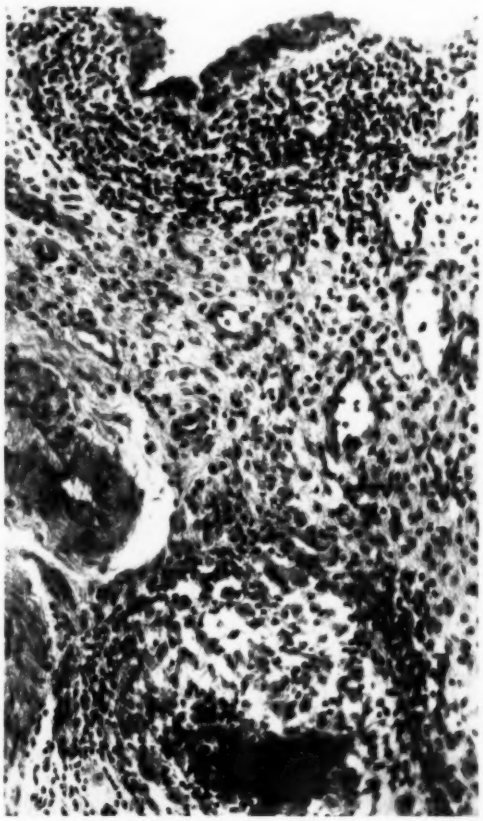

Fig. 2. Photomicrograph showing relation of a tubercle to the vesical mucosa. × 300.

pyelogram of the left kidney showed a small pelvis with upper calyces almost completely obliterated but normal middle and lower calyces. The ureter was markedly dilated.

Roentgenograms of the chest showed some calcified areas in both hilar regions but were otherwise normal.

A left nephrectomy was advised, but the patient refused operation. She was, therefore, discharged and was not seen again for 10 months (1 year after operation).

At this time she was still having frequency and nocturia. Her general condition was good. On cystoscopic examination a mild generalized cystitis was seen. The region of the left ureteral orifice was scarred and puckered, but there was no suggestion of any tumor. The left ureteral orifice could not be found.

The urine from the bladder was hazy with pus. The urine from the right kidney was normal.

The patient still refused a nephrectomy and was therefore started on ultraviolet therapy.

CASE 2. A married negress, 24 years of age, came to the hospital because of frequency and dysuria.

About 1 year before admission to the urological clinic she was on the gynecological service of the Lakeside Hospital. At that time she complained of lower abdominal pain, and by vaginal examination bilateral tubo-ovarian masses were felt. She did not have any vesical symptoms, however, and the urine was normal. A curettage and a bilateral salpingo-oophorectomy were done, but a small part of the right tubo-ovarian mass could not be removed. Following the operation, an abscess formed in the upper portion of the wound which resulted in a persistently discharging sinus. The pathological diagnoses of the removed specimens were tuberculous salpingitis, tuberculous oophoritis, and tuberculous endometritis.

For 11 months following operation she was free from all symptoms, but the abdominal sinus continued to discharge small amounts of pus. Repeated vaginal examinations made during this interval showed a persistent, indurated, slightly tender mass in the right side of the cul-de-sac. About a year after the operation, frequency, dysuria, and nocturia developed. These symptoms steadily became more severe, and she was, therefore, admitted to the urological clinic. The urine at this time contained a moderate number of pus cells but was negative for tubercle bacilli, both by microscopic examination and guinea pig inoculation. The blood Wassermann was negative.

Cystoscopic examination: The capacity and tone of the bladder were normal. On the posterior wall of the bladder and to the right of the midline, a definitely circumscribed, rose colored tumor was seen. It was about 2 centimeters in diameter and raised about 1 centimeter above the surrounding mucosa. The tumor was sessile and made up of large club-shaped villi. On close vision, some of these villi appeared to be cystic. The remainder of the bladder was normal. The urine from the bladder was turbid, and microscopic examination of the sediment showed pus cells to be present. The urine from each kidney was normal, but cultures made of the urine from both kidneys and the bladder showed a growth of bacillus coli from each of the three specimens.

A vaginal examination, done as soon as the cystoscopic examination had been completed, showed that the pelvic mass occupied a position corresponding to the region immediately posterior to the vesical lesion. In view of the cystic appearance of some of the villi of the tumor and its contiguity with the inflammatory pelvic mass, the lesion was diagnosed as an inflammatory reaction in the bladder wall.

The patient was advised to have another pelvic operation in order that the inflammatory mass could be removed, but this she refused to do. She has been followed in the Out Patient Department for the past 15 months. Her vesical symptoms have disappeared, but the pelvic mass persists and the abdominal sinus still discharges small amounts of pus.

The last cystoscopic examination, which was made 14 months after the first, showed the tumor to be the same size and in the same position. The surface of the lesion, however, had definitely changed. Its color was bright red, but no villi, vesicles, nor œdema were present. The remainder of the bladder was normal. The urine contained a moderate number of pus cells.

CASE 3. A married Hungarian woman, 27 years of age, came to the hospital because of marked frequency and dysuria.

She has had two children, and both are living and well. Her past history was unimportant until the birth of her second child 11 months ago. This labor was apparently normal, and although it was not followed by any fever or definite illness, still, she has not felt well since. Menstruation began again 3 months ago and has been regular but painful.

The present illness had a gradual onset 2 weeks before admission to the hospital, when she began to be troubled with frequency, nocturia, dysuria, and pain in the lower abdomen. The abdominal pain was dull and constant. These symptoms steadily became more marked, but the dysuria became extremely severe and was associated with tenesmus. On several occasions the patient noticed hæmaturia.

The physical examination showed a thin and very pale woman. The temperature, pulse, and respirations were essentially normal. The heart and lungs were normal. In the lower abdomen a firm, irregular, fixed, and slightly tender mass was felt. This mass was situated mainly in the left lower quadrant but also extended into the right lower quadrant for 5 centimeters beyond the midline. It seemed to rise out of the pelvis and extended from the symphysis pubis to a point 5 centimeters below the umbilicus. On vaginal examination a fixed tender mass could be felt bulging into the anterior vault of the vagina and extending laterally to the left. It seemed to be situated in the region of the base of the bladder.

Laboratory findings: hæmoglobin, 70 per cent; leucocyte count, 15,000; urine, turbid, acid; specific gravity, 1022; albumin, heavy trace; sugar, 0. Microscopic examination showed numerous pus cells, no red blood cells, no casts. No acid-fast bacilli could be found in the urine on two examinations. Phenolsulphonephthalein test: 60 per cent excreted in 2 hours and 10 minutes. Blood urea, 56 milligrams per 100 cubic centimeters. Blood Wassermann, negative.

Cystoscopic examination: The instrument was introduced without meeting any obstruction. The capacity of the bladder was limited, and marked vesical spasm was present. An extensive tumor was seen involving the posterior and left lateral walls of the bladder and also extending for a short distance on the right lateral wall. This tumor was sessile and of a reddish gray color. Its surface was covered by rounded villi. No ulceration was present. Around the edge was a moderate amount of œdema.

The lesion was considered to be an extensive and inoperable carcinoma of the bladder which had grown through the wall of the bladder and had invaded the surrounding pelvic structures. To give relief from the vesical symptoms, of which the patient complained bitterly, it was thought advisable to transplant both ureters into the rectum.

Operation: Under nitrous oxide anæsthesia, a midline suprapubic incision was made. After opening the peritoneal cavity, a large, firm, inflammatory mass was found in the left side of the pelvis. It was adherent to the bladder, sigmoid, and several loops of small intestine. After freeing these structures, the left tube and ovary were found in the center of the mass. A few drops of pus were present around the tube. A left salpingo-oophorectomy was done, following which the bladder was carefully palpated. A firm, indurated area could be felt in the wall of the bladder near its base, but it was not possible to determine whether this was caused by a neoplasm or an inflammatory reaction. However, it was considered inadvisable to open the bladder at this time. A drain was inserted into the pelvis and the wound closed.

Pathological report: The sections of the tube showed a chronic inflammatory reaction with a marked infiltration of mononuclear cells. The lesion was suggestive of tuberculosis but there was not enough evidence present to make a positive diagnosis.

The postoperative course was stormy. On the first day after operation, the temperature rose sharply to 40 degrees C. and then gradually came down to a lower level. It never reached normal, however, and for the remainder of her hospital stay (38 days) it fluctuated between 37 and 38.5 degrees C. During this time, a moderate amount of pus continued to discharge from the drainage tract, the granulations of which were pale and watery. Soon after the operation, the vesical symptoms began to subside, and within 2 weeks they disappeared. The urine at this time contained very few leucocytes.

Eighteen days after the operation a cystoscopic examination was again made. The site of the "tumor" now showed only a localized area of congestion, but there was no elevation of the mucosa nor any other condition suggestive of a tumor. The remainder of the bladder was normal.

About 1 month after operation, the wound began to drain unsatisfactorily, and the patient again began to have some dysuria. Cystoscopic examination at this time showed a definite bulging of the posterior wall of the bladder. On the surface of this bulging area were scattered minute nodules, but the general appearance of the lesion was different from that found at the first examination. One of these small nodules was excised for microscopic examination by means of a cystoscopic rongeur.

Pathological report: Serial sections made from the small piece of tissue showed vesical mucosa beneath which there was a mononuclear leucocytic infiltration and young fibroblastic tissue. There was no evidence of tuberculosis or malignancy. Diagnosis: chronic inflammatory tissue.

A vaginal examination at this time gave evidence of a diffuse pelvic inflammatory disease. There was a small mass which could be felt through the left fornix and a larger indurated mass was present posterior.

Thirty-eight days after operation the patient insisted upon leaving the hospital. She was still having a slight elevation of temperature (38 to 38.5 degrees), and the wound was still discharging a moderate amount of thick pus. Her vesical symptoms, however, had again disappeared and her urine was normal.

The patient was not seen again until 8 months later. The wound had healed completely 6 weeks after she left the hospital. She looked and felt well. There were no vesical symptoms and urinalysis was negative. A cystoscopic examination was again made and a normal bladder was seen. A vaginal examination showed the uterus to be freely movable and in the midline. A small residual mass was still present in the region of the right tube, but otherwise the pelvis seemed to be normal.

Our first case is especially interesting in that a localized tuberculous lesion of the wall of the bladder resulted from a tuberculous kidney instead of the usual generalized tuberculous cystitis. A possible explanation of this is that the tuberculoma at the left ureteral orifice completely occluded this opening and thus did not permit the constant pouring into the bladder of urine infected with tubercle bacilli. In support of this view we have the following facts: (1) the urine from the bladder was free from pus until the tuberculoma was removed; (2) the unobstructed kidney was extremely hyperactive (excreted 40 per cent of phenolsulphonephthalein in 15 minutes); (3) 2 weeks after removal of the tuberculoma, the left kidney was still functioning so poorly that it apparently did not excrete any indigocarmine.

Cases 2 and 3 are instances of an inflammatory reaction being set up in the wall of the bladder by contiguity. In both cases the primary seat of the inflammation was in the adnexa uteri, one being definitely tuberculous in origin and the other probably so.

The symptoms in these three cases consisted of dysuria, frequency, nocturia, pyuria in two of the cases, and in one case a history of hæmaturia was obtained. Cimino's cases had similar symptoms.

It can readily be seen from the symptomatology and cystoscopic findings that a differential diagnosis between an inflammatory tumor of the bladder and a true neoplasm is difficult. Our three cases were examined cystoscopically, and in each a definite tumor of the bladder was seen. Cimino's cases also showed the presence of such a lesion. Incidentally, this author claims that a differential diagnosis should be easy. The points which he considers important in the differential diagnosis are "negative heredity, the youth of the patient, the good general condition of the patient, history of trauma to the region, infection of near or distant organs, the mild character of the hæmaturia if present, amenableness to treatment, absence of neoplastic fragments in the urine, absence of metastases and glandular enlargements, and the frequent presence of fever." We feel that much stress cannot be laid on these points, since one frequently sees cases of carcinoma of the bladder in which all these conditions are present, except that they are not readily amenable to treatment. The youth of the patient may be against the diagnosis of carcinoma but is not sufficient to exclude this possibility.

On cystoscopic examination, however, these inflammatory tumors do exhibit certain characteristics which may aid in differentiating them from true neoplasms. Thus, instead of having a definite papillary appearance, they are made up of fairly large, club-shaped villi, some of which may appear cystic or translucent. Their color is usually of a *rosy red hue*. They show no evidence of invading the surrounding mucosa. In none of our cases or any that Cimino reports was there ulceration present. While none of these characteristics is typical only of an inflammatory tumor, still, when taken altogether they may aid in correctly diagnosing a doubtful lesion of the bladder. Cimino makes the statement, "thus we see that the only thing necessary is to think of the possibility of the inflammatory nature of the tumor and the diagnosis can be made even without the aid of the cystoscope." In our experience, we have found that the diagnosis is not so easily made, but it is of great importance that the possibility of the inflammatory nature of the tumor be borne in mind. The symptoms may very closely simulate those of a true neoplasm, and even on cystoscopic examination one may be unable to determine whether the lesion is neoplastic or inflammatory. In one of our cases (Case 1), the lesion was even considered to be a neoplasm when it was inspected and palpated at operation, and only after the microscopic sections had been examined was its true nature learned. In those cases in which the tumor is suspected of not being a true neoplastic lesion a biopsy may aid in the diagnosis.

SUMMARY

Three cases of inflammatory tumors of the bladder are reported: one, a tuberculoma, and the other two, local inflammatory reactions caused by contiguous inflammation.

These inflammatory lesions closely simulate a true neoplasm.

Differential diagnosis is often difficult.

The possibility of such a lesion should always be borne in mind, especially in women, and in those cases in which any doubt exists a biopsy may aid in arriving at the correct diagnosis.

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URETERAL STRICTURE, ITS ANATOMICAL AND PATHOLOGICAL BACKGROUND

Based Upon the Findings in One Hundred Consecutive Autopsies[1]

By MARTIN SCHREIBER, M.D., New York
Assistant in the Surgical Clinic of Dr. Beer, Mt. Sinai Hospital

THIS study was undertaken at the suggestion of Dr. Edwin Beer to test at the autopsy table, by both anatomical and pathological data, the conception lying behind that clinical entity which has been given the name of ureteral stricture. The evidence forming the background for this concept has been for the most part indirect in nature, that is, pyelographic and cystoscopic, the latter chiefly the wax-bulb hang method of Hunner.

Our data—gross anatomical and gross pathological, checked by histological and clinical—were to answer these questions:

Does there exist such a pathological entity as predicated by Hunner and his followers?

If it does exist, is its incidence as great as these reports would lead us to believe?

If it exists, what rôle, if any, does focal infection play in its etiology?

If focal infection is found to be not a factor, what is then the true pathogenesis?

What are the finer and yet gross "physiological" anatomical structural forms that may give to pyelographic and wax-bulb methods those clinical signs that are interpreted as ureteral stricture?

At this juncture a brief survey of the extensive literature is indicated. The literature groups itself into two main categories: that pertaining to the gross and histological anatomy of the ureter, and that pertaining to the clinical subjects of ureteral stricture, obstruction, or stenosis.

The latter falls into two large groups relative in time to the work of Hunner, for, following the year 1910—in which Hunner first began to emphasize the importance of this subject—up to the present, there has been an abrupt increase both in the intensity of interest and in the number of clinical, postmortem, and operative reports.

SUMMARY OF PERTINENT FACTS IN THE LITERATURE PERTAINING TO THE GROSS ANATOMY OF THE URETER

Embryology. According to Hertwig, the ureter is derived from the wolffian duct as a bud from its dorsal surface, beginning near its termination into the cloaca. This bud progresses cephalad, dorsad, and mesiad and bifurcates at its upper extremity to form the primitive calyces. These jut into the mesodermal cap, the primitive ultimate renal parenchyma.

The common stalk junction of the wolffian duct (ultimate vas deferens) and the ultimate ureter are drawn into the urogenital sinus, deeper and deeper into the bladder wall, downward and forward, so that the wolffian duct orifice comes to occupy its ultimate position as the ejaculatory duct orifice in the prostatic urethra, while the ureteral orifice finds its ultimate rest superiorly, posteriorly, and laterally as the lateral extremity of the trigonum vesicæ. The separation of the ultimate ureter from the ultimate vas deferens at their bladder extremities appear as the result of this drawing-in process.

Measurements of the ureter. Width. Adrenal portion, 6 millimeters; upper isthmus, 3.2 millimeters; chief spindle, 8 to 15 millimeters; lower isthmus, 4 millimeters (Waldeyer).

Length. The intramural portion of the ureter is 2 centimeters long according to Papin and is 2 to 3 millimeters at the ends, being slightly dilated in the middle.

The physiological zones of narrowing. In an unpicked autopsy series of 1,200 infants varying in age from 2½ to 9 months, Englisch found as "normal" the following three sites of narrowing in the ureter: (1) at the pyelo-ureteral junction; (2) at a variable distance below this; (3) at the bladder entrance.

The last, namely, the narrowing at the bladder entrance, was the most constant and was found in the greater percentage of cases (figures not given). The upper two narrowings were very much less constant. This work also brought out the fact that the site of aberrant renal vessels corresponds with the site of the physiological pyelo-ureteral zone of narrowing. These facts were then sub-

[1] This investigation was conducted during the tenure of a Daniel Guggenheim fellowship, and completed February, 1926; the autopsies were conducted at the Senkenberg Pathological Institute, University of Frankfurt am Main (Director, Professor Bernhard Fischer).

stantiated by him in an unpicked series of premature and newly born infants.

Robinson examined, postmortem, 200 ureters filled with air, with paraffin and with radio opaque substances. He also found three zones of widening and three of narrowing, the latter being in the pyelo-ureteral, the iliac, and the juxtavesical regions.

Posner by epidioscopy examined, postmortem, a series of ureters of newly born infants and found two zones of narrowing: one superiorly, believed to be due to the crossing of the spermatic artery, and the second inferiorly corresponding to the crossing of the ureter over the iliac artery.

Schewkunenko found in a series of 213 autopsies that the juxtavesical region was the narrowest portion of the ureter, outside of the ureteral orifice.

Ureteral valves. Woelffler in a postmortem series of 100 newly born infants found valve formation in 20 per cent, usually 1 to 1.5 centimeters up from the ureteral orifice; and in a postmortem series of 50 adults, he found *none* with valve formation.

Papin states that valves are rarely found, their incidence and importance being grossly exaggerated.

Basing his conclusions upon his autopsy series of 1,200 infants, Englisch concluded that ureteral valves are of congenital formation and not secondary to pathological changes.

It is of interest to note that George Daniel Goschwitz in 1723 first described ureteral valves in autopsy material.

The pelvic ureter. The pelvic portion of the ureter has been the subject of major study by several anatomists. According to Waldeyer, it can be divided for descriptive purposes into (a) the parietal portion (from the crossing of the ureter over the iliac artery to a point opposite the ischial spine), and (b) the visceral (from the ischial spine to the ureteral orifice). On the other hand, Tandler has emphasized the relationship of the female pelvic ureter to the uterine artery and has divided the pelvic ureter into: (a) the supra-arterial, (b) the arterial or subarterial ureter, and (c) the infra-arterial ureter.

Basing his conclusions on the careful dissections of five fresh and prepared pelves, Heiss maintained that Tandler's division relative to the uterine artery was better than Waldeyer's, for only in extreme cachexia does the pelvic ureter come into relationship with the ischial spine, being usually separated from this structure by a thick pad of fatty connective tissue. He also found that the two fixed points, the crossing of the ureter over the iliac vessels and the crossing of the vas deferens over the ureter, are altered by distention of the bladder and rectum.

Schewkunenko examined the ureters in 213 autopsies—to determine the cause of hindrance 2 to 3 centimeters up in the ureter during cystoscopic ureteral catheterization and found that (a) the mural portion of the ureter took a slanting direction through the bladder wall; (b) the mural portion was widened at its middle; (c) the juxtavesical region of the ureter was the narrowest portion of the ureter outside of the ureteral orifice; (d) *the juxtavesical narrowing, or chief isthmus, was the chief cause of hindrance, and was accentuated in 3 per cent of his cases; and* (e) *parametritis with subsequent para-ureteral connective tissue changes might accentuate this hindrance, this parametritis having been found in 8 to 10 per cent of females.*

Woelffler substantiated the above in an autopsy series of 50 adults by finding the juxtavesical region to be a site of constant narrowing.

In this connection, it is important to note that both Tandler and Schafer emphasize the marked increase in longitudinal musculature as the ureter reaches and traverses the bladder, Schafer emphasizing the fact that in this bladder region the muscularis is entirely longitudinal.

Histology. Stoehr, writing alone, and Bohm and Davidoff agree in their histological descriptions of the ureter: (1) a layer of stratified epithelium with surface cuboidal or columnar cells lying upon (2) a tunica propria composed of loose connective tissue carrying capillary blood and lymph vessels with few elastic fibers and few scattered lymphocytes; (3) a tunica muscularis of smooth muscle bundles divided into an inner longitudinal, a middle circular and an outer longitudinal layer, present only in the lower half; (4) an adventitia of loose fatty connective tissue carrying blood- and lymph-vessels and nerves.

Tandler and Schafer emphasize the longitudinal muscularis in the bladder region.

SUMMARY OF THE PERTINENT FACTS IN THE LITERATURE, BEFORE 1910, PERTAINING TO THE SUBJECTS OF URETERAL STRICTURE, STENOSIS, OR OBSTRUCTION

Autopsy reports. Englisch, reporting in 1879 upon the findings in an unpicked series of 1,200 infant cadavers, established not only the three normal sites of narrowing of the ureter as the pyelo-ureteral, iliac, and juxtavesical, but in addition found 65 cases of so-called congenital hydronephroses or an autopsy incidence of 5.4 per cent.

Of these cases, 34 were due to an accentuation of the normal narrowing at the pyelo-ureteral junction, 28 were due to an accentuation of the normal juxtavesical narrowing, and only 3 were found to be due to a narrowing at a site between these two points.

He concluded that the prime etiological factor in hydronephrosis is a *congenitally exaggerated narrowing* of a physiologically narrow site.

Schwartz (1896) presented a large collection of cases of hydronephrosis due to *congenital malformation* of all types.

Welz in 1903 presented an autopsy report of a case of atresia of the ureter, and collected 19 others from the literature. He emphasized the embryonal etiology.

Robinson in 1904 presented an autopsy series with drawings of cases of ureteral obstruction and stenoses. This included two cases of peri-ureteritis with dilatation and scarring of the ureter secondary to gonorrhœal tubo-ovarian disease and a case of congenital ureteral stenosis at the bladder entrance with hydronephrosis.

Operative reports before 1910 are rare. However, in that year Sternberg presented a specimen of marked left hydro-ureteronephrosis due to a very densely stenotic zone 1.5 centimeters long at the juxtavesical region.

SUMMARY OF PERTINENT FACTS PERTAINING TO THE SUBJECTS OF URETERAL STRICTURE, STENOSIS, OR OBSTRUCTION IN THE LITERATURE SINCE 1910

This material can be divided into 3 groups: autopsy reports, operative reports, and the large group of clinical reports, with and without pyelographic and wax-bulb evidence.

Autopsy reports. The autopsy reports of hydronephrosis secondary to ureteral stricture or stenoses have been many. Isolated case reports coupled with parallel cases from the literature vie in importance with more or less lengthy autopsy series such as that of von Meysen who reported 39 cases collected from the material at Bonn. The more or less comprehensive case reports of Verhoogen and De Graewe, Zimmerman, von Meysen, Wason, Hauser, Gruber and Bing, and Blatt, all emphasize congenital malformation, an embryonal developmental aplasia resulting in atresia, as the prime etiological factor.

Hauser suggested maldevelopment or malseparation of the ureter and vas from their common anlage, the wolffian duct, as an explanation for many cases of juxtavesical atresia of the ureter.

Operative reports. The operative reports have been increasing in number during the past 5 to 10 years.

Kahn reported a case of hydro-ureteronephrosis with infection in which a water tight valve fold was found in the pelvic ureter.

Aschner presented a case in which operation revealed an "aplastic condition in the upper ureter," and another in which an almost impassable stricture was found 4 centimeters above the ureteral orifice.

Oelsner presented an operative specimen of right hydro-ureteronephrosis with infection and with two stricture zones—one at the pyelo-ureteral junction which he interpreted as due to aberrant renal vessels; and a second in the iliac region, as etiological factor for which he emphasized a past history of operations for suppurative appendicitis and suppurative right adnexal disease.

Anspach reported a case of hydro-ureteronephrosis due to a stricture at the juxtavesical region treated successfully by nephropexy and ureteral dilatation. Walther reported a case of calculus apparently secondary to stricture obstruction at the site of the ligamentum latum.

Richardson in 1924 presented 3 cases operated upon, in each of which a definite stricture was found; one secondary to a traumatic ureterovaginal fistula; the second a case of very dense stricture in the ligamentum latum region and the last, a case of bifid ureter with a calculus impacted above a strictured zone in the lower ureter.

Perlman gave a comprehensive review of the literature and followed this by a report of 7 cases of ureteral stricture, 6 with corroborative operative findings, of which 3 were of tuberculous nature.

Hunner, in his series of reports, presents many operative cases which will be included in the general summary of his work, to follow shortly.

On the other hand, Morrissey reports 5 cases operated upon, with the pre-operative diagnosis of ureteral stricture, in four of which nothing was found and in the fifth an aberrant vessel, which was questionably of etiological importance.

Clinical reports. The work of Hunner summarizes for the most part the bulk of these reports. In his series of papers from 1911 to 1925, he emphasized the following points relative to ureteral stricture:

The incidence is very much greater than it was previously and generally believed to be. Hunner's last reports are based on 2,000 personal cases.

The importance is great in differential diagnosis, not only in diseases of the genito-urinary tract, but in all obscure abdominal conditions.

The cause, of predominatingly great importance, is an *intrinsic inflammatory process* of the ureteral wall, *metastatic* in nature, due to focal infection from the teeth, tonsils, or sinuses. The diagnosis is made through the history, by the cystoscopic wax-bulb hang method, and through pyelography. The common location is in the ligamentum latum region or at the crossing of the iliac vessels; and the condition is usually bilateral. Ureteral stricture is an etiological factor in (1) calculus formation and in (2) essential hæmaturia. Latent (symptomless) hydronephrosis is frequently present. Recently its importance in relation to obstetrics has been recognized. The peri-ureteral nerve plexuses bear an important relationship to hydronephrotic pain.

The mass of clinical reports that have been published during the past 15 years following Hunner's lead have for the most part been presentations of smaller or larger series of cases substantiating his views.

Rathbun emphasized not only the high incidence but also intraperitoneal pelvic inflammatory processes as of etiological importance.

Herbst and Thompson emphasized extension of inflammatory processes from prostate and seminal vesicles as of etiological importance.

Lawes, Dabney, and Green emphasize its importance in differential diagnosis in obscure abdominal conditions.

Baker and Walther emphasize focal infection as of etiological importance. The evidence of the former, a tabular presentation of oral infection incidence in cases presenting stricture symptoms and signs, may be as much coincidental as relative.

Turlington and Goldstein presented series of 115 and 23 cases respectively, with pyelographic and wax bulb evidence confirming Hunner's views.

Eisendrath has emphasized the anatomical pitfalls in diagnosis and Braasch the pyelographic.

Caulk presented a case of megalo-ureter, apparently due to obstruction at the ureterovesical region, interpreted by him as a "valve" and treated successfully by intravesical operations.

Desnos summarized the entire status of the question of ureteral stricture and emphasized trauma, either from stone or operation with secondary infection from the bladder, as of prime etiological importance.

DEFINITION OF TERMS

Before we go farther, it is advisable to define specifically several descriptive terms that will be frequently used.

The regional zones of the ureter in male and female subjects are shown in Figures 1a and 1b.

The gross descriptive term *dense* or *density* used in the description of the gross ureteral wall as seen from its mucosal surface after the ureter had been split along its anterior aspect, is used to convey the impression that the ureteral wall in a particular region appeared, relative to other portions of the ureter, as though its tissues were more solid, more compact, firmer, tougher, less elastic, and whiter.

This term has been applied usually to narrow, stenotic, stricture, or suspected stricture zones, or to entire portions of the ureter such as the postarterial or juxtavesical regions.

It is to be emphasized that this is a descriptive term for the *gross* specimen, which has been always subsequently checked by histological findings.

Varying degrees of density have been expressed through a scale of one plus (+) to three plus (+++).

MATERIAL AND METHOD

The observations and conclusions in this report are based upon 4 types of material: (1) autopsy material, (2) histological preparations, (3) clinical records, and (4) autopsy records.

1. *Autopsy material.* The autopsy material consisted of 100 consecutive unpicked autopsies done at the Senkenberg Pathological

Institute, Frankfurt am Main, comprising 42 adult males, ages 22 to 87 years; 37 adult females, ages 20 to 81; and 21 children, ages seventh month prenatal to 15 years.

The author personally assisted at every autopsy to inspect the peritoneal situs, abdominal and pelvic, and to note all gross findings in each autopsy relative to the subject of ureteral stricture, such as intraperitoneal tumors, glands, aberrant vessels, old and recent inflammatory processes.

The kidneys, ureters, and all pelvic organs in each case were left undisturbed for subsequent examination and dissection. After careful examination of these organs *in situ*, the entire pelvic contents, with ureters attached, were dissected free *en masse*, retroperitoneally, by cutting through the pelvic diaphragm, anal canal, upper vagina below the cervix, and the urethra. The entire mass was then carefully dissected out, particular attention being paid to (1) the course of the ureter; (2) the ligamentum latum with the crossing of the uterine artery over the ureter; (3) the presence of uterine prolapse or cystocele; (4) the course and ureteral relations of the vas deferens; (5) the seminal vesicles and prostate; (6) the iliac and hypogastric vessels and glands; (7) the bladder both from its external and internal surface.

In each case, the ureters were catheterized, to furnish a rough preliminary estimate of their caliber, and to indicate their course and relation to other structures.

The ureters were then split from their vesical orifices to the pelvis along their ventral aspect, with fine probe-pointed scissors, the uterine artery or the vas deferens being thus divided in their course. *The ureter was then examined carefully for both physiological and pathological zones of narrowing and widening, and changes in density in its wall. The pelvic ureter was of prime interest.*

The ureter was then measured at its presenting sites of narrowing and widening. It was spread out on a hard flat surface to its maximum width at each site before measurements were noted. Measurements of width were noted in millimeters, being really the length of the internal (mucosal) circumference. All measurements of length were noted in centimeters and then sites in the ureter were determined in "centimeters up" from the ureteral orifice. The length of the pars muralis, as well as the "distance up" from the ureteral orifice, of the crossing of the vas deferens or the uterine artery were noted in practically all cases. Drawings, notes, and measurements in each case were made at the autopsy table.

Sections of ureter were taken in almost all cases for histological examination, as control of gross observations, both positive and negative. The entire pelvic ureter from the iliac zone of narrowing down to and including the pars muralis was usually taken with a more or less thick mass of underlying subureteral tissue, comprising vas, seminal vesicle, fatty connective tissue, blood vessels, and nerves. *This gave, in continuity, various zones of the ureter with the underlying tissue for observation and comparison.* When any section was too long, it was split in two and the two parts were then mounted on the same slide. The lumbar and pyelo-ureteral regions were taken only when indicated for examination or control. Specimens for histological examination were immediately placed in formalin, after having been spread out on slips of bristol.

2. *Histological specimens.* These were imbedded in paraffin, *longitudinal sagittal sections made* and stained with three stains, hæmatoxylin-eosin, van Gieson connective tissue-muscle, and Weigert elastin. The sections were mounted under long cover slips on ordinary object glasses.

At this point, it would be well to state that all histological slides and observations in this study have been gone over and checked by Dr. Karl Plenge, chief of the histological department at the Charité in Berlin, and assistant to Professor Lubarsch at the Pathological Institute in that hospital.

The photomicrographs in this article have been prepared by Hugo Hinterberger, instructor in photography at the University of Vienna.

3. *Clinical records.* The clinical records were examined for: (a) history of urinary disturbance; (b) history of focal infection; (c) history of, or relative to, ureteral stricture;

(d) physical findings relative to the urinary tract; and (e) physical findings relative to focal infection.

4. *Autopsy protocol.* The autopsy protocol as prepared by the pathologist who made the complete examination was investigated as to the (a) chief anatomical diagnoses; (b) the special anatomical diagnoses that might be relative to a ureteral stricture; and (c) the special anatomical findings of focal infection. The teeth, tonsils, and ethmoid, sphenoid, and frontal sinuses were especially investigated in every case.

EXPOSITION OF FINDINGS

In the semi-diagrammatic drawings used in this article to illustrate our gross findings, the numbers found within the ureter at various sites in its course, represent in millimeters the width at this site—after the ureter had been split. The degree of density of the ureteral wall is represented by various tones of gray—unshaded or white, meaning soft, supple, less solid.

This investigation, in which attention was centered upon the ureters, revealed the surprising fact that 26 cases, or 26 per cent of our entire series, presented some type of ureteral disease. A grouping of these 100 cases into 79 adults and 21 children, gives the even more surprising result of a little less than 31 per cent, or 25 in a series of 79 unselected consecutive adult autopsies, presenting some type of ureteral disease.

These figures serve to emphasize the relative importance of the ureter as compared with other structures.

Before examining any of these cases in detail, the entire 26 will be presented in tabular summary.

A. Cases in which the ureteral pathological findings were of *primary origin in the ureter*, a total of 5 cases:

Adult Female—3 Cases

Case 42. Right pyelo-ureteral stenosis with hydronephrosis.

Case 79. Right pyelo-ureteral stenosis with hydronephrosis.

Case 98. Congenital anomaly. Right complete division of entire ureter with two orifices opening into bladder. Left bifid ureter with hydro-ureteronephrosis.

Adult Male—2 Cases

Case 24. Right bifid ureter down to iliac region with hydro-ureteronephrosis.

Case 97. Left juxtavesical stenosis with hydro-ureteronephrosis.

B. Cases in which the ureteral pathological findings were *secondary* in etiological sequence to a neighboring pathological process, a total of 21.

Adult Female—9 Cases

Case 58. Bilateral chronic fibrotic pelvic ureteritis, with secondary healed infected hydro-ureteronephrosis, secondary to old bilateral adnexal disease, with pelvic peritonitis, retroperitoneal cellulitis, and thrombophlebitis.

Case 74. Bilateral chronic and subacute pelvic ureteritis with secondary pyonephrosis (infected hydro-ureteronephrosis) secondary to bilateral chronic and subacute active tubo-ovarian abscess with pelvic peritonitis (retroperitoneal cellulitis).

Case 18. Stenosis of the ureter in the left ligamentum latum region—secondary to old subureteral scar.

Case 7. Narrowing of ureter with subureteral scar in left ligamentum latum region (?) secondary to traction of large cyst of the right adnexa.

Case 85. Marked fibrosis of external half of ureteral wall secondary to chronic ascending lymphangeitis of ureteral wall from chronic cystitis.

Case 30. Subacute ureteritis of lower ureter secondary to cystitis (cystica).

Case 20. Kink of right ureter at site of crossing of right uterine artery with right hydro-ureteronephrosis, secondary to prolapse of uterus.

Case 94. Marked hypertrophy of external longitudinal muscle bundles of pelvic ureter, secondary to prolapse of uterus.

Case 51. Localized dilatation with scarring or hypertrophy of wall of left postarterial ureter, at site of a firmly adherent left ovary.

Adult Male—10 Cases

Case 8. Localized stricture in the right juxtavesical region, secondary to localized chronic ureteritis, secondary to chronic neurological cystitis, secondary to old fracture of third lumbar vertebra with transverse traumatic myelitis. Right hydroureter.

Case 7. Hypertrophy and dilatation of ureter secondary to prostatic obstruction.

Case 27. Hypertrophy and dilatation of ureter secondary to prostatic obstruction.

Case 91. Hypertrophy of muscularis of ureter secondary to prostatic obstruction.

Case 92. Sclerofibrosis of external half of ureteral wall, secondary to prostatic obstruction (hypertrophic or chronic lymphangeitis).

Case 88. Sclerofibrosis of infravasal portion of ureter, secondary to prostatic obstruction (hypertrophic or chronic lymphangeitis).

Case 26. Subacute ureteritis of lower 5 centimeters of ureter, secondary to subacute (uræmic?) cystitis.

Case 21. *Grossly*—negative. *Microscopically*—shows active subacute retroperitoneal cellulitis, secondary to tuberculous peritonitis with mixed infection, extending through subureteral fatty tissue into ureter wall.

Case 36. *Grossly*—negative. *Microscopically*—lymphatic leukæmic (or lymphomatous) foci.

Case 96. *Grossly*—negative. *Microscopically*—lymphatic leukæmic deposits.

Children—2 Cases

Case 66. Narrowing of ureter with subureteral fibrosis at site of crossing over lateral umbilical ligament, obliterated hypogastric artery.

Case 23. *Grossly*—negative. *Microscopically*—lymphatic leukæmic deposits.

Added to the above list of 26 cases, there are 2 which we can classify as borderline cases between the physiological and that type of definitely pathological, which is exemplified by Case 97, juxtavesical (congenital) stenosis with hydro-ureteronephrosis. These 2 cases, numbers 32 and 61, will be discussed more fully later.

It will be seen from this summary that we have found an autopsy incidence of 8 per cent of all types of hydro-ureteronephrosis. In every one of these cases, the diagnosis of the hydro-ureteronephrosis was made by gross inspection. Indefinite doubtful cases have not been included. In addition to this 8 per cent of definite hydro-ureteronephrosis, we have found 5 cases in which the ureters were definitely dilated above an obstruction but without definite gross dilatation of pelvis and calyces, making a grand total of 13 per cent autopsy incidence of hydro-ureteronephrosis secondary to obstruction.

In these 13 cases of hydro-ureteronephrosis due to urinary obstruction, the ureter was the site of obstruction in all except one case, that being one of prostatic hypertrophy without compression stenosis of the ureter by the vas, as described by Tandler and Zuckerkandl. The ureteral obstruction in the 12 other cases was due to a narrowing or stenosis in 10, and an irregular dilatation coincident with or secondary to a post-inflammatory scarring of the ureteral wall in 2.

Of the 10 cases of stenosis of the ureter with a secondary hydro-ureteronephrosis, 5 or 50 per cent (5 per cent of all our cases) were congenital. Of the remaining 5 cases, 2 either were caused by, or were coincident with, localized subureteral scarring in the region of the ligamentum latum, 2 were due to kinking of the ureter over anatomical structures, in one over the uterine artery, in the other over the vas deferens; and the remaining single case was the only one caused by a chronic fibrotic inflammatory process involving the ureteral wall in such a way as partially to occlude its lumen. However, this localized fibrotic ureteritis (in the juxtavesical region) was definitely secondary to an active and intense acute and chronic cystitis, either through the medium of direct or lymphatic extension. There was not a single case in which the lesion required the hypothesis of blood borne focal infection for its complete explanation.

The details of the above 12 cases of ureteral obstruction follow:

CASES OF URETERAL OBSTRUCTION DUE TO STENOTIC NARROWING APPARENTLY OF CONGENITAL ORIGIN (DEFECTIVE EMBRYOLOGICAL DEVELOPMENT)

Case 97. Autopsy 1314. Male, age 27. The clinical diagnosis was acute diffuse peritonitis, secondary to ruptured appendix. The history and physical examination were negative both as to the urinary tract and focal infection.

Postmortem findings. Gross. The right kidney and ureter were negative (Fig. 2a). The left kidney and ureter showed marked left hydro-ureteronephrosis above the site of obstruction in the juxtavesical region (Fig. 2b). Gall stones and cryptic tonsils were noted as potential foci of infection. Microscopic. The right ureter was negative, save for acute retroperitoneal (periureteral) cellulitis, secondary to acute diffuse purulent peritonitis, extending into the ureteral wall in the form of œdema and a moderate infiltration of scattered and densely packed mononuclear cells.

For the condition of the left ureter, see Figures 2c and 2d.

It will be noted that:

1. This hydro-ureteronephrosis was a clinically latent condition.

2. There was no evidence of recent or past inflammatory process in the left juxtavesical region.

3. The separate, large and distinct oblique muscle masses in this region may have been of etiological importance in the hydro-ureteronephrosis, in that they may have

produced an inco-ordinated, incompletely relaxing, sphincter function.

4. The ureters are definitely involved in an inflammatory process extending from the peritoneal cavity through the peritoneum and retroperitoneal cellular tissue into the ureteral wall, this inflammatory involvement of ureteral wall having no etiological relationship to the left hydro-ureteronephrosis.

5. *The site of obstructive pathological narrowing is at a usual site of non-obstructive physiological narrowing.*

6. Two foci of infection were present.

Case 42. Autopsy 1226. Female, age 75. The clinical diagnosis was circulatory insufficiency, secondary to myodegeneration of the heart. The history and physical examination were negative relative to urinary tract and focal infection.

Postmortem findings. Gross. Right hydronephrosis, without infection, was secondary to stenosis of the lumen with slight increased density of the wall at the pyelo-ureteral junction. No aberrant vessel or other extrinsic structure of possible etiological importance was present at this site. The right ureter below this point, as well as the left kidney and ureter were negative.

Two possible foci of infection were cryptic tonsils and gall stones.

Microscopic sections of right and left pelvic ureters were negative; none was taken through the right pyelo-ureteral region; however, see the following, Case 79.

Case 79. Autopsy 1291. Female, age 73. The clinical diagnosis was bronchopneumonia. The history and physical examination were negative relative to urinary tract and focal infection.

Postmortem findings. Gross. (Fig. 3a.) Right hydronephrosis, without infection, was secondary to stenosis of the lumen with slight increase of density of the wall at the pyelo-ureteral junction. The right ureter below this point as well as the left kidney and ureter were negative.

Microscopic. See Figure 3b.

In the above 2 cases, it will be noted that:

1. The hydronephrosis was clinically latent, and the kidneys had remained uninfected despite the ages of the patients (75 and 73), and despite the presence of two foci of infection in the first.

2. *The site of obstructive pathological narrowing was found at the usual site of non-obstructive physiological narrowing, the former seeming but an accentuation of the latter.*

3. No aberrant vessels were found at this site.

4. The sagittal sections taken through the stenotic area of the second case show a non-inflammatory process, apparently a hyperplastic musculo-connective tissue deposit in this region.

Case 24. Autopsy 1202. Male, age 47. The clinical diagnosis was bacteræmia (sepsis). The history was negative relative to urinary tract and focal infection. The physical examination shows female habitus with infantile sex organs.

Postmortem findings. Gross (Fig. 4). Right hydro-ureteronephrosis was secondary to stenosis of both branches of a bifid ureter. There was narrowing of both branches with increase in density of the wall at the site of their junction at crossing over the iliac vessels 11 centimeters up from the common ureteral orifice in the bladder; and dilatation (hydro-ureter) of both branches above the stenotic site with moderate dilatation of their common trunk, the pelvic ureter, below this site.

Cholelithiasis was present.

It will be noted that this condition was clinically latent and no infection was present despite the patient's years and his focus of infection, the gall bladder. A maldevelopment of the external genitalia in addition to the urinary tract anomaly was present.

Case 98. Autopsy 1315. Female, age 52. The clinical diagnosis was lung abscess. The history and physical examination were negative relative to urinary tract and focal infection.

Postmortem findings are shown in Figure 5.

It will be noted that:

1. On the right side we have an atrophy of the kidney, not of hydronephrotic origin, a developmental aplasia perhaps secondary to defective embryological vascularization.

2. On the left side, however, hydronephrotic atrophy was secondary to an obstructive narrowing at the junction zone of the two branches of a bifid ureter. There was ureteral dilatation above and below this site.

3. This condition was clinically latent and the organs remained uninfected.

CASES OF URETERAL OBSTRUCTION DUE TO STENOTIC NARROWING, SECONDARY TO A PATHOLOGICAL PROCESS IN THE "NEIGHBORHOOD"

Case 28. Autopsy 1206. Female, age 64. The clinical diagnosis was pneumonia, diabetes, and hypertension. The history and physical examination was negative relative to the genito-urinary tract and focal infection.

Postmortem findings. Gross. The right ureter was dilated to 20 millimeters above the site of crossing of a calcified uterine artery, 3 centimeters above the ureteral orifice. Below this site the juxtavesical and mural portions of the ureter were relatively narrow, only 10 millimeters. The left ureter (Fig. 6a) showed stenosis at the site of crossing of the uterine artery 4.5 centimeters up in the ligamentum latum region, with ureteral dilatation both below and above this site. Bilateral adnexal adhesions and cryptic tonsils were present.

Microscopic sections showed on the right hypertrophy of the longitudinal musculature with marked infra-arterial longitudinal muscle mass in the proportion of 1 to 4. An old organizing thrombus was in the subureteral vein. There was a subureteral scar at the site of the stenosis in the left ureter. See Figure 6b and compare with Figure 6a.

In this case it will be noted that:

1. The ureters were dilated above the ligamentum latum region on both sides, which causes us to suspect a descensus uteri which may have been missed both clinically and on postmortem examination.

2. On the right side we also found a subureteral venous thrombosis, which suggests a periphlebitic process extending into the ureteral wall as an explanation of the gross and histological picture seen on the left side.

3. This thrombophlebitis may be secondary to the suspected descensus uteri or it may be secondary to the inflammatory process of the adnexa which resulted in the adhesions found at autopsy.

4. This bilateral ureteral dilatation was clinically latent.

Case 4. Autopsy 1163. Female, age 77. The clinical diagnosis was cardiac insufficiency and bronchopneumonia. The history and physical examination were negative relative to the genito-urinary tract and focal infection.

Postmortem findings. Gross. A massive cyst of the right adnexa reached up to the diaphragm filling half of the peritoneal cavity. The right ureter was negative. The left ureter was stenosed and an increase in density could be noted under the left broad ligament.

Microscopically, the stenosed area is seen to be the site of fibrosis in the subureteral fat. This fibrosis apparently owes its origin to a fibrotic periphlebitis, secondary to subureteral venous varicosities in this region, apparently the uterine veins.

Case 8. Autopsy 1172. Male, age 37. The clinical diagnosis was fractured spine, cystopyelitis, and confluent bronchopneumonia. The history and physical examination, showing fracture of the third lumbar vertebra with traumatic transverse myelitis and secondary chronic and subacute cystitis, were otherwise negative.

Postmortem findings. Gross. The bladder was markedly thickened and contracted; chronic cystitis. The left ureter was thickened, firm, chronically inflamed, and slightly dilated to 13 millimeters in its entire course. The condition of the right ureter is shown in Figure 7a.

The microscopic specimen is shown in Figure 7b.

This case was the only one found in which the obstructive stenotic lesion of the ureter was due to the chronic intrinsic inflammatory process in the ureteral wall. However, it is clear that in this case the inflammatory process was due to direct or lymphatic extension from the neurological cystitis and we need no hypothesis of blood borne infection from a distant focus to explain its pathogenesis.

Case 20. Autopsy 1196. Female, age 67. The clinical diagnosis was tertiary lues, descensus (prolapsus) uteri, and spontaneous fracture of the right femur. The history and physical examination revealed poor teeth and descensus uteri. Relative to genito-urinary tract and focal infection it was otherwise negative.

Postmortem findings. Gross. The right kidney and ureter are shown in Figure 8. The moderate hydronephrotic atrophy of the right kidney with hydro-ureteronephrosis was secondary to ureteral obstruction at the site of crossing of the uterine artery, 2.5 centimeters up. Apparently a kink obstruction of the right ureter due to traction on the uterine artery crossing the ureter was caused by descensus uteri. The left kidney and ureter were essentially negative. Possible foci of infection were the cryptic tonsils and gall stones.

Microscopic. The left ureter was essentially negative. The right ureter presented a chronic inflammatory process in the infra-arterial, undilated portion, evidenced by slight mononuclear infiltration of the tunica with œdema, excessive fibrosis of intermuscular connective tissue with zones of moderate and dense mononuclear infiltration, and dilatation and congestion of the blood vessels. In the periureteral tissues in this region, there was marked sclerosis and varix formation of the veins with and without old thrombi. The periureteral fat presented moderate subureteral fibrosis with zones of new vessel formation.

Case 27. Autopsy 1205. Male, age 84. The clinical diagnosis was diabetes and bronchopneumonia. The history and physical examination were negative relative to the genito-urinary tract and to focal infection.

Postmortem findings. Gross. Moderate prostatic hypertrophy of the median lobe was noted. The right ureter was negative. The left ureter is shown in Figure 9.

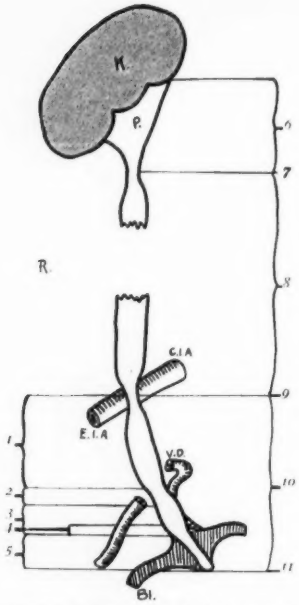

Fig. 1a. Anatomical division of the ureter in the male. *K*, Kidney; *P*, pelvis; *C. I. A.*, common iliac artery; *E. I. A.*, external iliac artery; *V. D.*, vas deferens; *Bl*, bladder; *R*, right side. *1*, Parietal or prevasal or supravasal portion of pelvic ureter; *2*, pars vas deferens; *3*, pars postvasal or infravasal deferens; *4*, juxtavesical region or chief isthmus (Schewkenemko); *5*, pars muralis; *6*, pelvis; *7*, pyelo-ureteral junction or pyelo-ureteral zone of narrowing or upper isthmus or adrenal narrowing; *8*, lumbar or chief spindle or lumbar enlargement of lumbar ureter; *9*, iliac narrowing or lower isthmus; *10*, pelvic ureter; *11*, ureteral orifice.

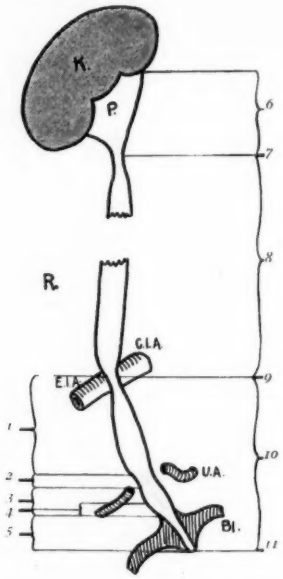

Fig. 1b. Anatomical divisions of the ureter in the female. *K*, Kidney; *P*, pelvis; *C. I. A.*, common iliac artery; *E. I. A.*, external iliac artery; *U. A.*, uterine artery; *Bl*, bladder; *R*, right side. *1*, Parietal or pre-arterial or supra-arterial preligamentous ureter; *2*, pars arterialis-subarterialis or pars ligamentum latum; *3*, pars postarterial or infra-arterialis; *4*, juxtavesical zone or chief isthmus; *5*, pars muralis; *6*, pelvis; *7*, pyelo-ureteral junction or pyelo-ureteral zone of narrowing or upper isthmus or adrenal narrowing; *8*, lumbar or chief spindle or lumbar enlargement or lumbar ureter; *9*, iliac zone of narrowing or lower isthmus; *10*, pelvic ureter; *11*, ureteral orifice.

Microscopically, both right and left ureteral walls presented marked hypertrophy of the muscular coat, the individual smooth muscle bundles being increased two to three times in thickness, compared with the normal of this patient's age and size.

The above 2 cases are prototypes of a common type of low ureteral obstruction. The site of obstruction, which is due to kink-narrowing of the lumen of the ureter, by the uterine artery crossing in the female in the condition of descensus uteri, and by the vas deferens crossing in the male in prostatic hypertrophy, is found usually between 1 and 5 centimeters up from the ureteral orifice.

This condition in the female has been described pathologically by Virchow, Zimmer, Tandler-Halban, and Hirokawa, and its clinical importance in the more advanced stages has been emphasized by Rubin.

The male type has only recently been described and its clinical importance emphasized by Tandler and Zuckerkandl.

CASES OF URETERAL OBSTRUCTION WITHOUT STENOSIS OR NARROWING DUE TO POST-INFLAMMATORY SCARRING OF THE URETERAL WALL

Case 74. Autopsy 1285. Female, age 47. The clinical diagnosis was cardiac insufficiency, ascites, diabetes, tertiary lues, cystopyelitis; the history and physical examination showed "kidney infection" 6 months before death.

Postmortem findings. Gross. Bilateral suppurative hydronephrosis was present. The right and left ureter are shown in Figure 10a. A bilateral tubo-ovarian abscess mass was overlying the course of the pelvic ureter. The tonsils were cryptic.

Microscopic findings. See Figure 10b.

Case 58. Autopsy 1257. Female, age 59. The clinical diagnosis was carcinoma of the breast.

Bilateral breast amputation for mammary carcinoma had been done. The history and physical examination were negative relative to the genito-urinary tract or focal infection.

Postmortem findings. Gross. The entire pelvic peritoneal cavity was obliterated, except for a small portion behind the right ligamentum latum, by dense firm peritoneal adhesions binding all pelvic organs into a dense firm mass. Scars were in the pyramids and pelves of both kidneys. The right and left ureters were relatively the same (Fig. 11a).

Microscopic findings (Figs. 11b and 11c).

In the above 2 cases, the following points should be emphasized.

1. The involvement of the ureter secondary to the adnexal disease was very destructive.

2. The intense ureteritis was localized to the pelvic ureter with only very slight inflammatory changes in the ureter above the iliac crossing.

3. *Secondary dilatation was present above the marked pelvic ureteritis, despite the fact that there was no stenosis.* The inflammatory destruction of muscularis and elastica in the pelvic ureter, coupled with the periureteral fibrosis and perhaps the neurological disturbances secondary to the peri-ureteritis, very likely caused urinary stasis, with secondary hydro-ureteronephrosis by affecting the peristaltic propulsive and expulsive functions of the pelvic ureteral wall.

4. Active and fibrotic perineuritis and periganglionitis were very marked. This picture may explain much obscure genito-urinary symptomatology.

5. There were evidences of healed marked thrombophlebitis of periureteral veins with extension of a periphlebitic process into the ureteral wall.

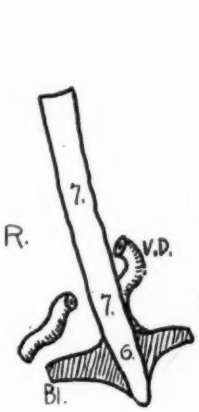

Fig. 2a.

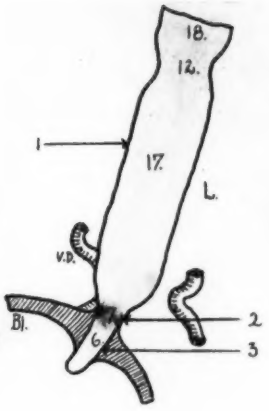

Fig 2b.

Fig. 2a. Case 97, autopsy No. 1314. Right side negative; compare with Figure 2b. *Bl*, Bladder; *V. D.*, vas deferens, crossing at 3 centimeters.

Fig. 2b. Same case as in Figure 2a. Latent hydronephrosis without infection. *1*, Entire left ureter dilated, thickened, hypertrophic, above *2*, the left juxta vesical region. Compare with Figure 2a. *3*, Narrow pars muralis, 1.8 centimeters long. *V. D.*, Vas deferens crossed ureter at 3.5 centimeters; *Bl*, bladder. The left kidney showed marked hydronephrosis with dilated pelvis and calyces and thinning of the parenchyma.

SUMMARY OF FINDINGS IN TWELVE CASES

The finding of the above 12 cases in our unselected 100 consecutive autopsies suggests that the importance and incidence of hydro-ureteronephrosis have been generally underestimated; and that Hunner's emphasis of this condition is justified.

From the standpoint of pathogenesis and etiology of hydro-ureteronephrosis, I would call attention particularly to the following:

a. Pathological congenital ureteral narrowings, which usually appear as *accentuated* narrowings of a physiological narrow site, usually either at the pyelo-ureteral junction zone or at the juxtavesical zone.

b. Extension into the ureteral wall of neighboring inflammatory processes, especially adnexal disease in the female and advanced cystitis. In the former, thrombophlebitis of the uterine plexus at the base of the broad ligament, with periphlebitis, is an important factor.

c. The potential kinking power of the two structures that cross the ureter, namely the vas deferens and the uterine artery.

d. The importance of focal infection is not evident.

Hunner's clinical localization of most of his stenotic lesions in the lower pelvic ureter, from 2 to 5 centimeters up from the ureteral orifice, is substantiated by the pathological findings enumerated.

ANATOMICAL CONDITIONS INFLUENCING THE FEELING OF RESISTANCE TO THE WAX BULB

In this investigation, a number of anatomical conditions, both physiological and border-line, were encountered, which demand

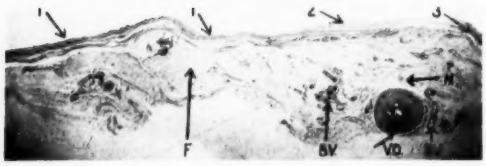

Fig. 2c. Case 97. Longitudinal sagittal section through left pelvic ureter, enlarged. Compare with gross findings, Figure 2b and high power photomicrograph, Figure 2d. *1*, Dilated, thickened, hypertrophic ureter above; *2*, thickened, dense (stenotic) juxtavesical zone (Fig. 2d); *3*, thin pars muralis; *F*, subureteral fat, œdematous; *V. D.*, vas deferens; *B. V.*, blood vessels; *N*, nerves. Patient died from diffuse purulent peritonitis.

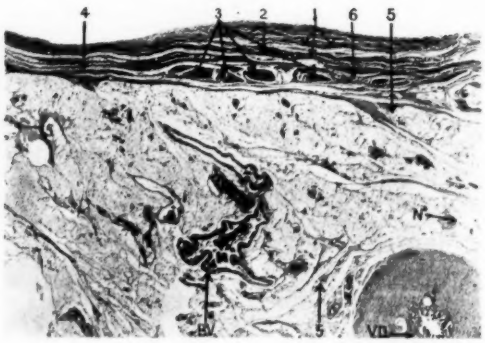

Fig. 2d. Case 97. Longitudinal sagittal section through stenotic, dense, left juxtavesical zone, enlarged. This localized, thickened, dense, stenotic zone is composed of, *1*, thick dense longitudinal muscle bundles separated by *2*, an excessive amount of thick, dense intermuscular connective tissue, most marked in the external half of the ureteral wall. This dense connective tissue continues upward, gradually thinning, to form the adventitial layers of the pelvic ureter, *4*; *5*, diffuse œdema of subureteral fat extending into the ureteral wall, *6*. *V. D.*, Vas deferens below juxtavesical region; *B. V.*, blood vessels; *N*, nerves with ganglion cells. Note relative to *5*, patient died with diffuse purulent peritonitis.

explanation especially from the standpoint of the interpretation of wax-bulb findings. It is presumed that a "hang," or the feeling of resistance on withdrawal, is due to a combination of two factors: (1) narrowing of the lumen of the ureter and (2) an increase in the density of its wall. The first, acting alone, could theoretically produce a hang by resisting the passage of the shoulder of the wax bulb. The second, acting without the first, should in theory produce no hang. However, the two acting together, theoretically, produce the true or pathological hang.

By far the greatest number of ureteral strictures reported diagnosed by the wax-bulb method, have been found in a region 2 to 5 centimeters up from the ureteral orifice. In this very region, however, we find the following gross and microscopic physiological anatomical conditions: the juxtavesical zone of narrowing, physiological narrowing of the pars arterialis and pars deferens, physio-

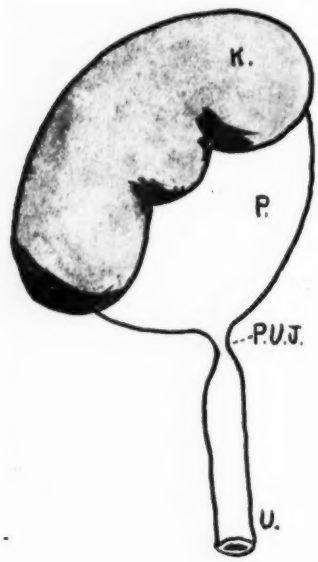

Fig. 3a. Case 79. Autopsy No. 1291. Female, aged 73. Latent right hydronephrosis. *P. U. J.*, Narrowing at site of right pyelo-ureteral junction with, *P*, pyelectasis and *K*, slightly hydronephrotic kidney; *U*, normal caliber ureter. No aberrant vessel or periureteral fibrosis is present at stenotic site. Compare with Figure 3b.

Fig. 3b. Longitudinal sagittal section through right pyelo-ureteral junction, Case 79, enlarged. *1*, Thinned, dilated pelvic wall—thin muscle bundles, few layers, *3–4*, very thin loose connective tissue; *2*, pyelo-ureteral junction, three to four times thicker than pelvis, with entire wall composed of densely packed thick muscle bundles, five or six layers running for the most part obliquely with *3*, very dense intermuscular connective tissue throughout wall; *4*, beginning of ureter.

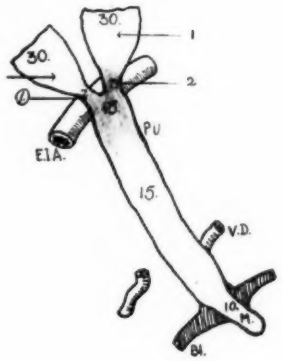

Fig. 4.

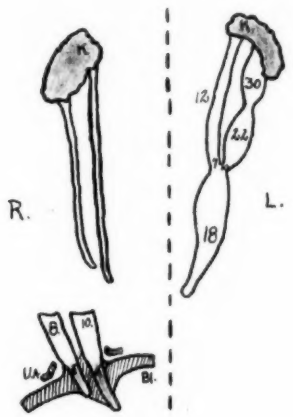

Fig. 5.

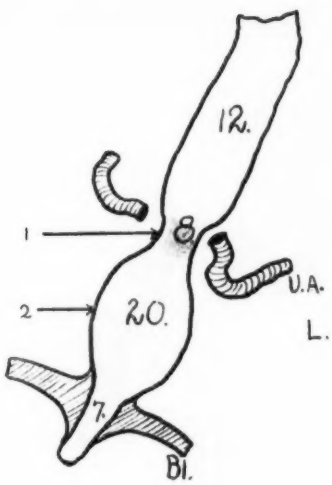

Fig. 6a.

Fig. 4. Case 24, autopsy No. 1202. Male, aged 47. Congenital anomaly of right ureter. Ureter bifidus down to crossing over iliac vessels, 11 centimeters up. *1*, Stenotic and dense junction ends of both upper branches; *2*, hydroureters above these two stenotic zones, leading to hydronephrotic kidney. *E. I. A.*, External iliac artery; *P. U.*, parietal ureter; *V. D.*, vas deferens crossing at 3 centimeters; *M*, pars muralis, 1.5 centimeters long; *Bl.*, bladder.

Fig. 5. Case 98. Autopsy No. 1315. Female aged 52. Diagrammatic representation of bilateral congenital anomaly or ureters. There is a complete split of right ureter (so-called double ureter) with two ureteral orifices in bladder, the upper lateral orifice leading to lower pole and the lower medial orifice leading to the upper pole. The right kidney is atrophic. On the left side there is a bifid ureter down to the midpoint of the lumbar ureter, 15 centimeters up, with hydro-ureteronephrosis and hydronephrotic shell of kidney.

Fig. 6a. Case 28. Autopsy No. 1206. Female, aged 64. Adnexal adhesions, bilateral ureteral dilatation, marked calcification of uterine arteries. *1*, Dense and narrow zone in left ureter at crossing of uterine artery, 4.5 centimeters up with dilatation above and below. (Compare with Figure 6b.) *2*, Infra-arterial ureter, not only dilated to 20 millimeters but also dense and thick. *U. A.*, Divided uterine artery crossing at 4.5 centimeters; *Bl*, bladder with pars muralis 2 centimeters long.

logical narrowing with subureteral fibrosis of that portion of the ureter overlying the obliterated hypogastric artery, and redundant folds of mucous membrane (so-called valve formation).

The juxtavesical zone of narrowing. This was investigated and emphasized by Schewkunenko. The zone varies in length from a few millimeters to 1 or 2 centimeters. Its upper limit is indefinite, but its lower limit is bounded anatomically by the proximal or upper limit of the pars muralis. In the adult female, this is found to average 2.2 centimeters up from the ureteral orifice; in the adult male, 1.9 centimeters up from the ureteral orifice, in children 1.1 centimeters up from the ureteral orifice; these three measurements being respectively the average length of the pars muralis in these three groups as estimated from our data.

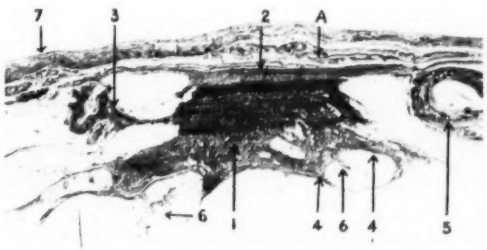

Fig. 6b. Case 28. Autopsy No. 1206. Female, aged 64. Longitudinal sagittal section showing *1*, localized, old, dense, thick subureteral scar, corresponding with zone of density and stenosis seen in gross in left ligamentum latum region, 4.5 centimeters up in ureter. (Compare with Figure 6a.) *2*, This scar tissue extends directly into the adventitia of the ureter at this site but apparently not into the muscularis. It spreads peripherally; *3*, perivascularly and *4*, between fat lobules intertrabecularly; *5*, a very markedly sclerotic and calcific blood vessel (vein) can be noted here immediately beneath the ureteral wall; *6*, nerve; *7*, ureteral wall in sagittal section; *A*, artifactal space.

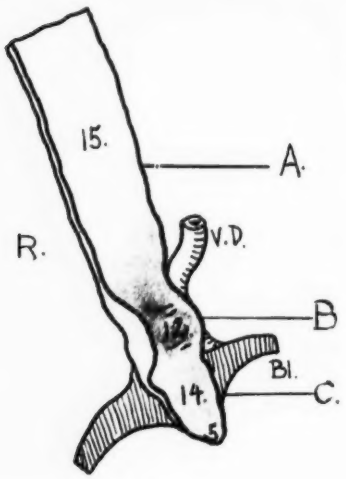

Fig. 7a.

Fig. 7a. Case 8, Autopsy No. 1172. Male, aged 37. Fracture of third lumbar vertebra with secondary (neurological) cystopyelitis. Contracted bladder. *B*, Localized, thick, firm, scarred, stenotic zone in juxtavesical portion of ureter; *A*, ureter above this zone soft, thin, slightly dilated; *C*, pars muralis, dilated but chronically inflamed 1.5 centimeters long. Compare with microscopic sections through these zones (Fig. 7b). *V. D.*, vas deferens; *Bl*, bladder. Right side.

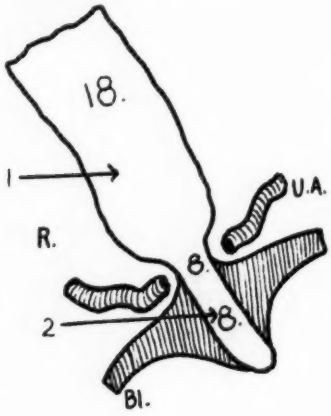

Fig. 8.

Fig. 8. Case 20. Autopsy No. 1196. Female, aged 67. Descensus uteri. *1*, Ureter dilated above the crossing of the uterine artery, *U. A.*, 2.5 centimeters up, in juxtavesical region; *2*, narrowing at and below this site; *Bl*, bladder with pars muralis 2.5 centimeters long. This ureter leads to a moderately hydronephroti · right kidney.

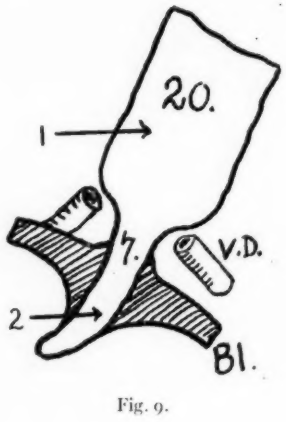

Fig. 9.

Fig. 9. Case 27. Autopsy No. 1205. Male, aged 84. Median lobe prostatic hypertrophy. *1*, Marked dilatation with thickening of entire ureter above site of crossing of vas deferens, *V. D.*, which crossed ureter 3.5 centimeters up, in juxtavesical region; *2*, undilated pars muralis and pars juxtavesicalis below vas deferens. *Bl*, bladder.

We cannot substantiate the findings of Schewkunenko, that the juxtavesical region is the narrowest portion of the ureter outside of the ureteral orifice. However, our findings would indicate the following:

There *is* a relatively *constant* narrowing at this site.

This is usually the site of a more or less gradual tapering down of the relatively wide infra-arterial or infravasal ureter to the relatively narrow pars muralis. The proportion of the former to the latter is on the

Fig. 7b.

Fig. 7b. Case 8. Microscopical horizontal sections through zones *A*, *B* and *C*. *A* was taken 2 centimeters above the stenotic zone. The wall is thin and is relatively free from inflammatory reaction. No œdema, fibrosis, or mononuclear infiltration except in the tunica propria can be seen. *B*, Stenotic zone. There is marked thickening of wall, active inflammatory process involves the entire wall. The tunica propria shows dense mononuclear infiltration with œdema and fibrosis. The muscularis shows marked œdema and mononuclear infiltration in the intermuscular connective tissue planes. The adventitia presents a picture of a chronic inflammatory process spreading or extending out from the ureter wall into the periureteral fat in the form of œdema, fibrosis and mononuclear infiltration. *C*, Pars muralis showing chronic inflammation of intermediate intensity between *A* and *B*. Moderately dense mononuclear infiltration throughout the wall with moderate œdema. Process spreads only very slightly beyond the outer muscular layer into the periureteral tissues. *F*, Periureteral fat; *U*, ureteral wall. *1*, Ureteral wall; *2*, periureteral fat; *3*, chronic inflammatory process extending out into periureteral fat; *4*, ureteral wall.

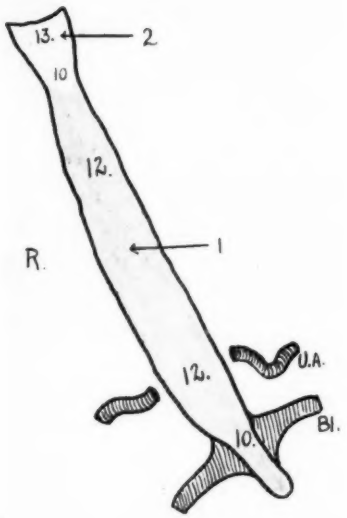

Fig. 10a. Case 74. Autopsy No. 1285. Female, aged 47. Bilateral subacute and chronic tubo-ovarian abscess. Bilateral pyonephrosis (suppurative hydronephrosis). *1*, Thickening with increase in density and slight dilatation of entire pelvic ureter with *2*, soft, thin lumbar ureter above the iliac narrowing; *U. A.*, uterine artery crossing at 3.5 centimeters; *Bl*, bladder with dilated pars muralis (10 millimeters) 2 centimeters long.

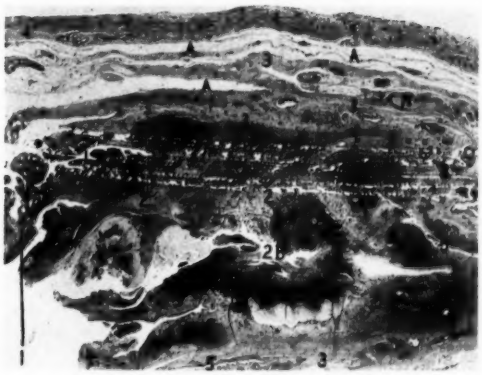

Fig. 10b. Case 74. Longitudinal sagittal section through ureter with subureteral tubo-ovarian inflammatory mass, enlarged. *1*, Acutely and chronically inflamed fallopian tube; *2*, acutely and chronically inflamed ovary with old *2a* and recent *2b* corpora lutea; *3*, chronically and acutely inflamed retroperitoneal and subureteral cellular tissue. This process extending to and through the ureteral adventitia into the, *4*, ureteral wall which is fibrotic, scarred, œdematous, infiltrated with mononuclear cells and intimately embedded in chronically inflamed periureteral scar tissue. The ureteral wall shows many dilated vessels with new vessel formation. *5*, Remains of periovarian peritoneal cavity. *N*, Nerve with fibrotic perineuritis; *A*, artifactal spaces.

average in the female as 11.1 is to 7, or as 3 is to 2. In the male the proportion is as 11 is to 6.7, or as 3 is to 2 — ; while in children, it is as 8 is to 4.4, or a little less than 2 to 1.

Furthermore, the juxtavesical region presents another constant physiological anatomical attribute which distinguishes it from other portions of the ureter. In the gross, this zone is seen to be the site of a relatively constant increase in density of its wall as compared with all portions of ureter above this site.

My sagittal sections show histologically that this density is caused by a constant change in the histological appearance of the wall of the juxtavesical region as compared with the ureter above. In the juxtavesical region, the muscularis is physiologically two to five times as thick as in the pars parietalis. Furthermore, this muscularis is not only thick, but as a layer, it is found to be composed of very thick and densely packed longitudinal muscle bundles, with very dense and thick intermuscular fibrous connective tissue bundles. And lastly, the tunica propria or sub-mucosa in this region is usually one-half as deep as that above and is composed of denser connective tissue. It should be pointed out that in neither the mural nor juxtavesical portion of the ureter are to be seen circularly disposed smooth muscle bundles to warrant the widely accepted conception of a true ureteral sphincter.

The intensity or degree of gross density of the pars juxtavesicalis is directly proportional to the histological thickness and density of the fibromuscular tunica as described above.

The gross and histological characteristics of the juxtavesical region can be well seen in Figures 12, 13, and 14.

Cases 61 and 32, autopsy numbers 1260 and 1210, represented by Figures 13 and 14 respectively, are borderline cases between the physiological, as described above, and that pathological type represented by Case 97. Autopsy 1314, and Figs. 2a, 2b, 2c, and 2d.

Case 97 presented a left hydro-ureteronephrosis due to a congenital stenosis of the

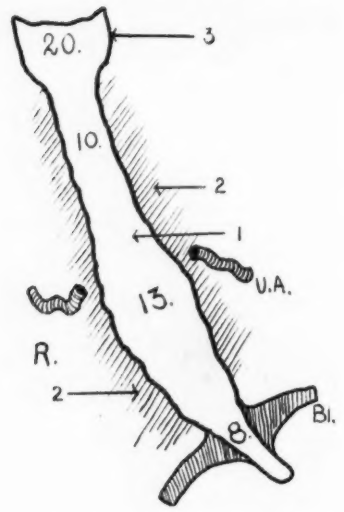

Fig. 11a. Case 58. Autopsy No. 1257. Female, aged 59. Bilateral dense pelvic peritoneal adhesions. Pyelitic scars in both kidneys. Bilateral dilated ureters, pelves, and calyces. *1*, Irregularly dilated, thick, dense, firm, fibrous, scarred, pelvic ureter, bound down in *2*, dense, firm, fibrous (scarred) periureteral (retroperitoneal) tissue; *3*, lumbar ureter, thin, soft, dilated to 20 millimeters. *U. A.*, Uterine artery crossing at 5 centimeters up; *Bl*, bladder with pars muralis 2.5 centimeters long. Compare with Figures 11b and 11c.

ureter at the juxtavesical region. This stenosis was evidently not due to narrowing alone, for despite the fact that this region is relatively narrow, compared with the dilated ureter above, it was nevertheless no narrower than the same region on the other side, which presented no hydro-ureteronephrosis. This would warrant the conclusion that the stenosis in this case was due mainly to a dysfunction, an unrelaxing sphincter-like site, which may be secondary to either the histological structural change which is seen as an excessive deposit of fibromuscular tissue at this site, or to a deposit of oblique or circular fibromuscular layers instead of the usual longitudinal.

The two borderline cases presented not only an excessively dense, fibrosclerotic, narrow juxtavesical region, in exaggeration of the normal, but also a relatively dilated ureter above this site. However, in neither was there gross dilatation of either pelvis or calyces, which forces them into a borderline group, if not into the physiological. In addition Case 61 presented in the left juxtavesical region, a distinct, thick mass or circularly disposed musculature, situated between an inner and an outer muscular layer.

I would emphasize that the ureteral wall in the juxtavesical region resembles that of the more densely fibromuscular vas deferens, which at one time in the embryological development of the ureter, formed its "anlage"

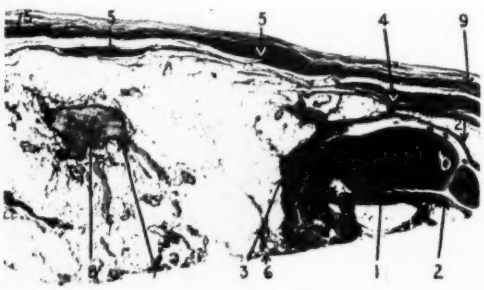

Fig. 11b. Case 58. Longitudinal sagittal section through right ureter and underlying tissue, enlarged. *1*, Old organized (fibrotic) thrombus in large vein in juxtavesical subureteral tissue; *2*, wall of vein with *3*, organized (fibrotic) periphlebitis extending directly into *4*, ureteral wall; *5*, irregular scarring of external half of ureteral wall with complete disappearance or distortion of muscularis in these regions; *6*, fibrosis in fat, intertrabecular; *7*, perineural fibrosis; *8*, nerve with ganglion cells; *9*, the pars muralis.

Fig. 11c. Case 58. Longitudinal sagittal section through left ureter and underlying tissues, enlarged. *1*, masses of irregular venous varices with, *1a*, and without, *1b*, thromboses, but all presenting, *2*, marked organized (fibrotic) periphlebitis extending into surrounding fat; *3*, masses of dense fibrous tissue which may be primary or secondary to the varices; *4*, fibrous (organized) perineuritis; *5*, intertrabecular (fatty) fibrosis; *6*, fibrosis extending into outer layers of ureter; *7*, fibrotic, scarred, external, longitudinal muscular layers; *8*, artifactal space; *9*, pars muralis.

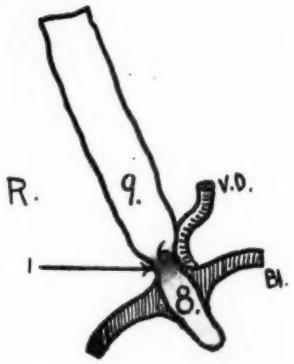

Fig. 12a. Case 40. Autopsy No. 1223. Boy, aged 15. *1*, Localized zone of narrowing and increased density in juxtavesical region 1.8 centimeters up, corresponding with site of crossing of vas deferens, *V. D.; Bl*, bladder with pars muralis 1.8 centimeters long. Compare with Figure 12b.

as the wolffian duct. Hauser reported a case of congenital left hydro-ureteronephrosis due to a very marked stenosis in the juxtavesical region, the etiology for which he assigns to a developmental defective separation of the ultimate ureter from its anlage, the wolffian duct or ultimate vas deferens.

Fig. 12b. Case 40. Longitudinal sagittal section, enlarged. *1*, very thick, dense, sharply localized, longitudinal muscle mass, occupying external half of ureteral wall in juxtavesical region. This mass of muscle is apparently a prolongation upward of, *2*, bladder musculature (localized hypertrophy or hyperplasia) and it thins as it proceeds upward in the ureter from its point of maximum thickness in juxtavesical region (over vas deferens); *3*, prolongation upward of external longitudinal muscle mass from juxtavesical region with gradual thinning to a fine thread-like layer in parietal portion of pelvic ureter; *4*, pars muralis; *5*, subureteral fat. The vas deferens was not included in this section.

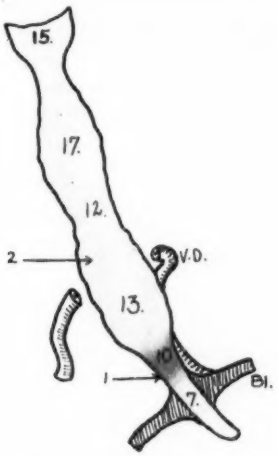

Fig. 13a. Case 61. Autopsy 1260. Male, aged 60. *1*, Marked density with slight narrowing in juxtavesical region. (Compare with Figure 13b.) *2*, Slight dilatation with slight increase in density of entire pelvic ureter; *V. D.*, vas deferens crossing at 6 centimeters; *Bl*, bladder with pars muralis 2 centimeters long.

Physiological narrowing of the pars arterialis. About 10 per cent of the adult female cases presented a zone of slight but definite narrowing of the ureter where it was crossed by the uterine artery. In none of these cases was there subureteral scarring as

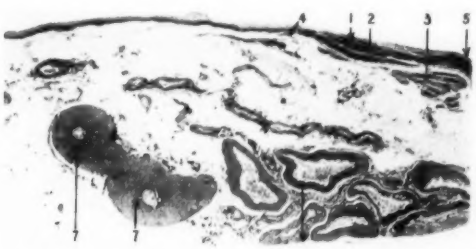

Fig. 13b. Case 61. Longitudinal sagittal section of ureter with underlying tissue, enlarged. *1*, Abrupt increase in thickness of ureter wall as one reaches juxtavesical region. Proportion of 4 or 5 to 1 with above. This increase of thickness of wall is due to, *2*, laying on of masses of longitudinal thick, smooth, muscle bundles, with dense intermuscular fibrous tissue, apparently continuous with bladder musculature; *3*, proportion of thickness of musculature in juxtavesical region with that in parietal ureter as 5 or 6 is to 1; *4*, gradual thinning out of juxtavesical, fibromuscular, longitudinal mass as it proceeds upward; *5*, pars muralis; *6*, seminal vesicle; and *7*, vas deferens.

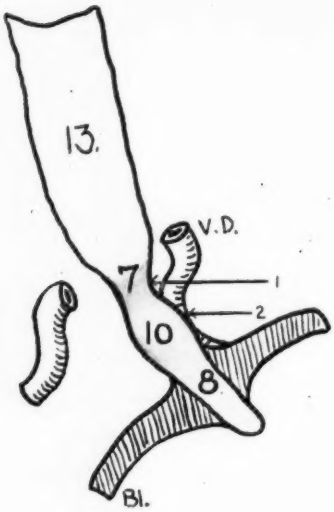

Fig. 14a. Case 32. Autopsy 1210. Male, aged 74. *1*, Narrowing and increased density in zone 3.5 centimeters up, site of crossing of vas deferens. (Compare with Figures 14b and c); *2*, dense infravasal (juxtavesical) ureter. *V. D.*, vas deferens; *Bl*, bladder with pars muralis 1.5 centimeters long.

in the 2 cases presented above. The site of crossing of the uterine artery varied between 2 and 6 centimeters up from the ureteral orifice.

Physiological narrowing of the pars vas deferens. At the site of crossing of the vas

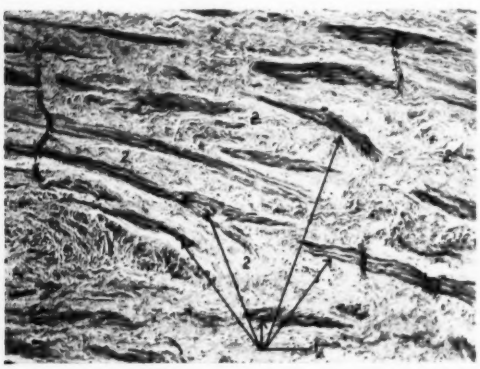

Fig. 14c. Case 32. High power photomicrograph of dense thick zone overlying vas deferens (Van Gieson stain). *1*, Scattered thick longitudinal muscle bundles; *2*, dense, fibrotic, sclerotic, intermuscular connective tissue, laid down in thick bundles.

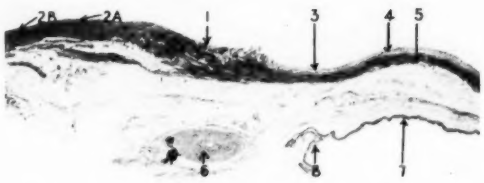

Fig. 14b. Case 32. Longitudinal sagittal section through pelvic ureter with underlying tissues, enlarged. *1*, Markedly thickened and dense zone of ureter overlying vas deferens (tunica propria in this region has been destroyed in the sectioning). The ureteral wall in this region is composed entirely of very dense, sclerotic, deeply staining fibrous tissue (scar) with thick, longitudinal smooth muscle bundles scattered irregularly throughout. No signs of active inflammation are present. (See Fig. 14c.) *2*, Below, this area merges with a thickened juxtavesical and mural ureter in which the entire wall is composed of regularly arranged but dense longitudinal muscle bundles with very dense intermuscular connective tissue; *3*, above, one sees the relatively thin supravasal pelvic ureter in which the wall can be seen to be divided into two zones—*4*, a lightly staining (tunica propria), loose connective tissue stratum and *5*, a densely staining outer two-thirds, the tunica muscularis, with its intermuscular connective tissue. This layer shows hypertrophy of its muscle bundles with markedly dense intermuscular connective tissue. *6*, Vas deferens; *7*, pelvic peritoneum. the parietal portion overlying the ureter. A zone of markedly dense, sclerotic, fibrotic retroperitoneal tissue is seen in the entire course. *8*, Beginning of cul-de-sac of Douglas.

deferens, the ureter was found physiologically narrowed in only about 5 per cent of our cases. In one of these cases (Case 32, Autopsy 1210, Figs. 14a, 14b, and 14c) the immediate infravasal and juxtavesical ureter was the site of a remarkable muscular and fibrous tissue hypertrophy and sclerosis.

Physiological narrowing with subureteral fibrosis of that portion of the ureter overlying the obliterated hypogastric artery (ligamentum latum umbilicale) was noted in only one case in our entire series of 100 cases (Figs. 16a and 16b).

Redundant folds of mucous membrane—so-called valve formation. Only one case of this type, that of a child 2½ years old, was found in this entire series (Figs. 17a and 17b). It will be noted that the ureter above this valve formation is relatively widened to 12 millimeters as compared with the left, 10 millimeters.

A smaller proportion of strictures have been reported in the iliac and pyelo-ureteral regions. These two regions, however, are also zones of congenital physiological narrowing.

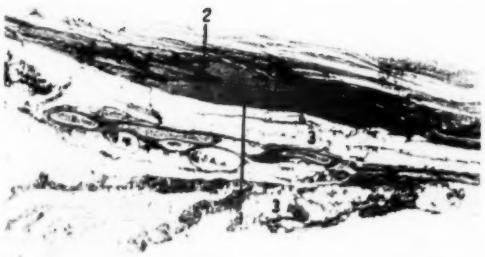

Fig. 15. Case 99. Autopsy No. 1318. Female, aged 57. Longitudinal sagittal section through ureter and underlying tissues at zone of iliac narrowing, enlarged (Van Gieson stain). *1*, Localized, thick, dense, hypertrophic or hyperplastic, external longitudinal smooth muscle mass, with *2*, deposit of very dense intermuscular fibrous connective tissue; *3*, periureteral fatty tissue; *4*, blood vessels.

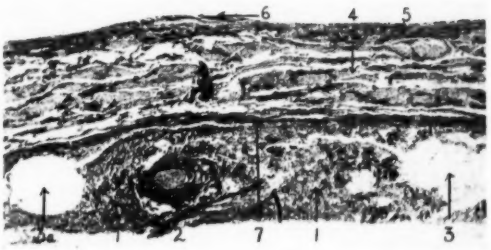

Fig. 16b. Case 66. Longitudinal sagittal section, enlarged (Van Gieson stain). *1*, Localized zone of fibrosis in subureteral fat extending directly up to and merging with ureteral adventitia. Compare with Figure 16a for corresponding area. *2*, Perineural fibrosis; *3*, fat lobules; *3a*, artifact, fat lobule without fatty alveoli; *4*, muscularis; *5*, tunica propria; *6*, epithelium; *7*, adventitia.

Accurate figures of incidence of these two narrowings cannot be given by us as only exaggerated narrowings were recorded in the first third of our series. However, our impression is that these two zones of narrowing are about equally constant, occurring in about 50 per cent of all cases, the degree of narrowing varying from the frankly physiological to the frankly pathological. We have presented 2 cases (Cases 42 and 79, Autopsies 1226 and 1291) of hydronephrosis due to accentuated stenotic or pathological narrowing of this physiologically narrow site (Figs. 3a and 3b).

We found no case of hydro-ureter or hydroureteronephrosis which could be ascribed to accentuated narrowing at the iliac site.

However, Case 99, Autopsy 1318, presented a marked physiological narrowing, from 12 millimeters in the pars parietalis to 9 millimeters in the iliac region, 9 centimeters up, plus a localized increase in density in this region. The sagittal section through this

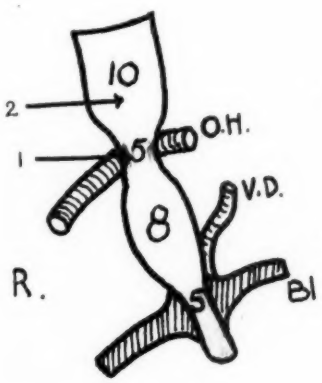

Fig. 16a.

Fig. 16a. Case 66. Autopsy No. 1271. Boy, aged 3 years. *1*, Narrowed and dense zone in ureter, 3 centimeters up, at site overlying the obliterated hypogastric artery, (this zone narrowing and increased density is shown in detail in Fig. 16b) *O. H.*, or ligamentum latum umbilicale. *2*, Relative dilatation above this site with no iliac zone of narrowing. *V. D.*, Vas deferens crossing at 1.5 centimeters; *Bl*, bladder with pars muralis 1 centimeter long. Compare with Figure 16b.

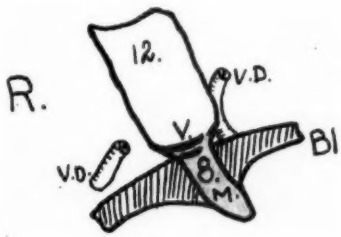

Fig. 17a.

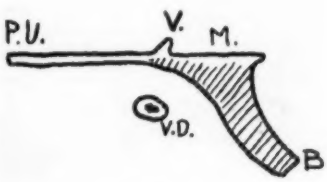

Fig. 17b.

Fig. 17a. Case 23. Autopsy No. 1201. Child, 2½ years old. *V*, Valve-like annular, redundant fold of mucous membrane in right juxtavesical region; *V. D.*, vas deferens, crossing at 2 centimeters; *Bl*, bladder with pars muralis 1.5 centimeters long. Ureter thin and soft, (?) dilated to 12 millimeters above annular fold.

Fig. 17b. Case 23. Diagrammatic representation of valve-like fold of redundant mucous membrane in right juxtavesical region. *V*, valve-like, annular fold, juxtavesical region; *M*, pars muralis; *P. U.*, parietal ureter; *V. D.*, vas deferens; *Bl*, bladder.

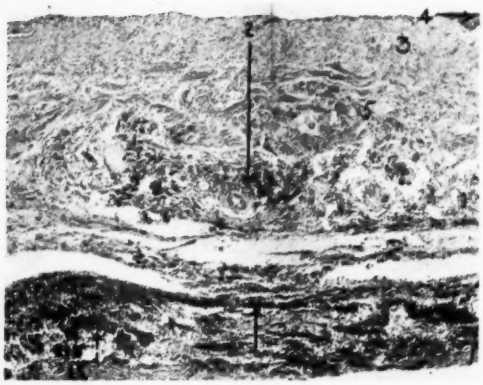

Fig. 18. Case 96. Autopsy No. 1313. Male, aged 55. Lymphatic leukæmia. Longitudinal sagittal section, enlarged. *1*, Very dense infiltrative deposits of small lymphocytes in adventitial periureteral layers of lumbar ureter; *2*, perivascular and intermuscular lymphatic deposits; *3*, tunica propria with, *4*, patch of epithelium, and *5*, muscularis.

zone (Fig. 15) is interesting not only as it explains the gross density observed, but also in comparison with Figure 3b, representing a similar section through a pyelo-ureteral stenotic zone.

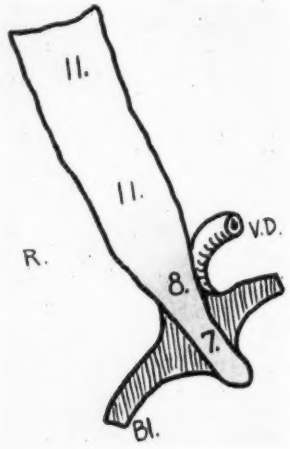

Fig. 19a. Case 21. Autopsy No. 1197. Male, aged 46. Marked fibro-adhesive tuberculous peritonitis with fæcal fistula, giving mixed peritonitis. In gross examination we find a relatively normal appearing ureter. *V. D.*, vas deferens crossed at 3.5 centimeters; *Bl*, bladder with pars muralis 2 centimeters long. A slight increase in density in juxtavesical region is physiological. Compare this "normal" appearance with microscopic picture (Fig. 19b).

Fig. 19b. Case 21. Longitudinal sagittal section through ureter wall with subureteral tissue, enlarged. Active subacute and chronic inflammatory process throughout subureteral fatty connective tissue, marked mononuclear infiltration with œdema, fibrosis and vascular dilatation and congestion. This process is seen not only in fat, *1*, perivascularly, *2*, and perineurally, *3*, but extends directly into ureteral wall through medium, *4*, of ureteral adventitia and then only in the form of œdema and fibrosis in intermuscular connective tissue planes, *5*. The tunica propria shows only œdema and capillary dilatation and congestion, *6*. *N*, Nerve with ganglion cells.

The following cases present several interesting and important types of pathological processes in the ureteral wall, but with no resultant ureteral obstruction.

Case 96, Figure 18, shows malignant lymphatic deposits in the ureteral wall and subureteral tissues. Two similar cases of this kind were found in this series. In no case was there any gross ureteral wall change secondary to these deposits.

Figures 19a and 19b present a ureter which showed no gross pathological findings, but which on microscopic examination revealed a definite inflammatory involvement of its wall, the result of direct extension of an inflammatory process from a mixed tuberculous and fæcal peritonitis through the retroperitoneal, subureteral cellular tissue into and through the ureteral adventitia.

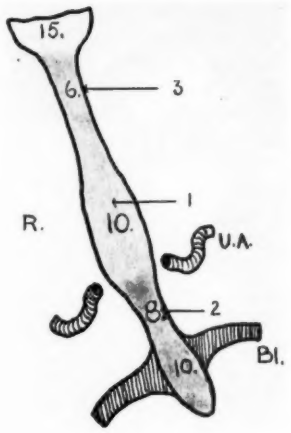

Fig. 20a.

Fig. 20a. Case 85. Autopsy 1299. Female, aged 77. Thickened, contracted bladder, marked cystitis. *1*, Entire pelvic ureter with increased density, marked in *2*, infra-arterial ureter (compare with Figure 20b); *3*, iliac narrowing begins at 7 centimeters and ends at 12 centimeters with relatively dilated ureter above. *U. A.*, Uterine artery crossing at 5.5 centimeters; *Bl*, bladder with pars muralis 3 centimeters long and dilated to 10 millimeters.

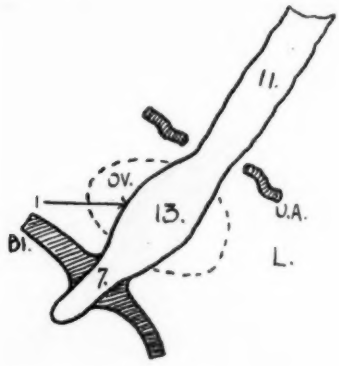

Fig. 22a.

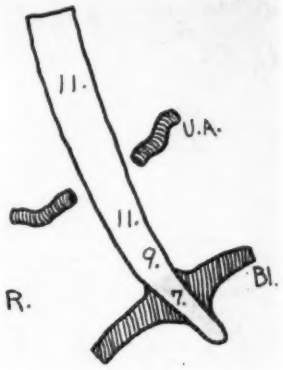

Fig. 22b.

Fig. 22a. Case 51. Autopsy 1240. Female, aged 53. Left ovary adherent to peritoneum over infra-arterial ureter. *1*, Dilated infra-arterial ureter with moderate increase in density. The ovary was adherent over the subligamentous course of the ureter by dense fibrous adhesions. See Figures 22b and c. *U. A.*, Uterine artery crossing at 5 centimeters; *Ov.*, ovary posteromedially; *Bl*, bladder with pars muralis 2 centimeters long.

Fig. 22b. Case 51. Showing "normal" right ureter for comparison and control with left ureter, Figure 22a. *U. A.*, Uterine artery crossing at 5 centimeters; *Bl*, bladder with pars muralis, 2 centimeters long.

The involvement of the ureter in an inflammatory process secondary to pelvic peritonitis can be seen in several stages from œdema alone to intense residual scarring in Figures. 2d, 19b, 11b, 11c. Figures 20a and 20b present what is very likely residual scarring of chronic lymphangeitis of the pelvic ureter, secondary to chronic cystitis. Figure 20b is strong evidence of the anatomical location of the ureteral lymphatics in outer layers of ureteral wall and also of the pathological hypothesis of ascending ureteral wall lympathic route of infection from bladder to kidney.

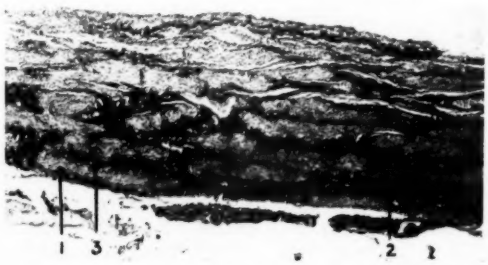

Fig. 20b. Case 85. Longitudinal sagittal section through pelvic ureter, enlarged. *1*, Thick hypertrophic bundles of longitudinal smooth musculature localized for the most part to external half of ureter. *2*, Very dense deposit of dense, thick, deeply staining intermuscular connective tissue, localized to external half of ureteral wall (fibrosis). *3*, Absence of inflammatory process in periureteral connective tissue (not seen well in this section). Fibrosis of external half of ureteral wall was present only in pelvic ureter, not above the iliac zone. The deposit of dense intermuscular connective tissue in external half of ureter accounts for gross density of ureteral wall observed, and is very likely secondary to chronic lymphangeitis of ureteral wall secondary to marked chronic cystitis.

Fig. 21. Case 72. Autopsy 1283. Longitudinal sagittal section of ureter and underlying tissues, enlarged. Female, aged 41. *1*, Mass of thickened, subureteral, venous varicosities with *2*, periphlebitic (?) fibrosis, *3*, ureter wall negative.

Fig. 22c. Longitudinal sagittal section, enlarged. *1*, From *A* to *B* localized zone in postarterial ureter corresponding to dilated and dense area seen in gross, over which ovary was adherent and in which the wall is definitely increased in thickness and density. *H. P.* in this area reveals a picture very similar to Figure 14c. This zone is seen to be composed of very dense, fibrotic, sclerotic connective tissue, through which thickened, (*?*) hypertrophic, long and short longitudinal smooth muscle bundles are irregularly scattered. This zone tapers down at either end into a thin juxtavesical region, *2*, with normal topography and histology and a thin-walled supra-arterial ureter, *3*, also with normal topography and histology. *4*, Bladder musculature with *5*, pars muralis; *6*, subureteral fat. Case of mild traction diverticulum formation in the postarterial ureter.

Figure 21 presents a mass of subureteral uterine vein varicosities which underlie a relatively normal ureter. This is presented only to emphasize its potential importance as an etiological factor in ureteral narrowing due to subureteral fibrosis, secondary to thrombophlebitis as is seen in Figures 11b, 11c and 6a and 6b. Either subureteral venous varicosities or subureteral venous thromboses or both were found in over 30 per cent of our adult female cases.

Figures 22a and 22c (with Fig. 22b for comparison) present a case of mild traction diverticulum formation in the postarterial ureter due to an ovary adherent over the course of the ureter. What is apparently a mechanical localized work hypertrophy of the wall of the ureter is seen in this region (Fig. 22c).

CONCLUSIONS

From the pathological, anatomical, and clinical data in 100 consecutive autopsies, it seems fair to conclude that:

1. Stricture of the ureter does exist as a definite pathological entity.

2. A 12 per cent postmortem incidence of ureteral stricture or stenosis corroborates the great number of ureter strictures or stenoses reported clinically.

3. Latent symptomless hydro-ureteronephroses due to ureter stricture or stenosis are of relatively frequent occurrence, as is evidenced by a postmortem incidence of 10 per cent in our series.

4. Ureteral stricture as a localized intrinsic inflammatory process in the ureteral wall, metastatic in character due to focal infection, apparently either does not occur, or is relatively extremely rare as compared with ureteral strictures or stenoses of other origin.

5. Ureteral stricture or stenosis is found most frequently in the pelvic ureter, in a zone about 2 to 6 centimeters up from the ureteral orifice.

6. As prime etiological factors in the pathogenesis of ureteral obstruction due to stricture and stenosis we would emphasize in the order named; (a) congenitally accentuated narrowing of a congenital physiologically narrow site; (b) extension of inflammatory processes into the ureteral wall from adnexal disease with and without thrombophlebitis, and advanced chronic cystitis; (c) the occluding kinking power of crossing anatomical structures, namely, the vas deferens in the male and the uterine artery in the female.

7. Caution is necessary in the interpretation of the physical signs obtained by the wax-bulb hang method of Hunner, especially in that very important region 2 to 6 centimeters up from the ureteral orifice, for in this region we find numerous physiological sites of narrowing and increased density of the ureteral wall, namely, (a) the juxtavesical zone; (b) the iliac zone; (c) the ligamentum latum region, the site of crossing of the uterine artery; (d) the vas deferens region, the site of crossing of the vas deferens; (e) the site of the obliterated hypogastric artery; and (f) the so-called "valve formation" in the juxtavesical region.

The writer takes this opportunity to thank Professor Bernhard Fischer, director of the Senkenberg Pathological Institute and professor of pathology at the University of Frankfurt, for the privilege of using this material as well as for the courteous and helpful consideration which this work was invariably accorded. To Professor Edgar Goldschmid, prosector and assistant director of the laboratory, the author's personal thanks are due for his stimulating criticisms as well as for many valuable practical suggestions.

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The recent reports of Hepburn, Pugh, Snyder, and Fletcher could not be obtained.

THE TREATMENT OF OSTEOMYELITIS AND OTHER INFECTED WOUNDS BY DRAINAGE AND REST[1]

By H. WINNETT ORR, M.D., F.A.C.S., Lincoln, Nebraska

WHEN Sir Joseph Lister undertook to apply the discoveries of Pasteur to surgical practice 50 years ago, he had one definite idea. His idea was that if fermenting micro-organisms could be excluded from wounds and if their activity could be inhibited by antiseptics, putrefaction, pyæmia, and the long train of wound complications could be avoided. Time and the weight of clinical evidence have proved that he was right. In his own lifetime, however, Lister departed from the use of carbolic acid and primary antisepsis or asepsis and embarked upon the search for a universal antiseptic. Lister's second choice was boracic acid.

We have sailed on many seas since Lister's time and thousands of other substances and combinations have been employed in the search for the ideal antiseptic.

Since the time of Lister, the usual conception of wound treatment has been that infection must be met and defeated by antiseptics. It should be remembered that infections of all kinds had been successfully overcome long before the time of surgeons or antiseptics. A study of the fossil remains of pre-historic animals reveals the presence of healed lesions of bone and joint infections of many kinds. Out of our present day notion as to the importance of antiseptics, there have developed certain errors in surgical practice to which I wish to call your attention and for which it is desired to propose a remedy.

In our use of antiseptics there undoubtedly has often been the same misapprehension with regard to cause and effect that obtains and has obtained in the use of other substances used as remedies in other kinds of disease. We have had occasion to try and to abandon hundreds of substances which were at one time relied upon as curative. Now we know that in diseases of many kinds recovery takes place quite regardless of the medicinal agents employed. If we scrutinize the methods employed in wound treatment, we shall have reason to doubt whether it has been generally discovered or recognized that infected wounds do heal without the application of antiseptic agents of any kind.

Before the antiseptic period the usefulness of certain agents in preventing fermentation of all kinds had been demonstrated in many ways.

For the preservation of human bodies after death, there had been developed methods over which very little improvement has been made. The control of fermentative processes outside of the body was being given considerable attention, although no high degree of perfection was reached until the discoveries of Pasteur. Substances and combinations similar to those used in embalming had been used to a certain extent in the treatment of wounds. They were used, for the most part, empirically because they seemed to promote healing.

Lanfrank[2], in the 14th century, had formulated quite definite and fairly successful methods of dealing with simple and infected wounds. He advocated and employed compresses, sutures, and special dressings for wounds of various kinds. He quoted from both Galen and Avicenna to emphasize the point that no attempt must be made to close septic wounds until they had been cleaned up.

Lanfrank reports a case in which primary healing occurred and says: "I found the wound and the vein all healed and the father and all the neighbors had great wonder."

One encounters the same sort of astonishment whenever patients are seen who are recovering and whose wounds are healing without active antiseptic treatment. It has, somehow, become a notion prevalent among the laity, as well as current in the profession, that a certain amount of treatment with poultices, packs, irrigations, or antiseptic

[2] Lanfrank. Science de Cirurgie, Ashmole MS., 1396, Early English Text Society, Orig. Series 102, 1894.

[1] Annual lecture in Orthopedic Surgery, January 25, 1927, Mayo Foundation, Rochester, Minnesota.

powders or pastes is necessary to persuade a wound to heal. The healing of a wound without any of these things is usually looked upon as an interesting and unusual phenomenon. It is the intention of the writer to show that wound healing may be brought about regularly without daily dressings or irrigation with antiseptics, and that there is an easier and better way to promote healing of wounds. The important factors in securing such results are primary asepsis or antisepsis when required, adequate drainage, immobilization of the injured parts, and protection of the wound against disturbance and reinfection.

Since the time of Lister there has developed a disposition on the part of the profession to regard wound treatment as a contest between the germs in the wound and the antiseptic that is being employed. (For severe infections more and stronger antiseptics!) To a certain extent the facts have been lost sight of that on the one hand, with every infected wound there is a certain amount of septicæmia against which the patient must battle himself, and which also may become better or worse according to the wound treatment employed; and that, on the other hand, not only may the antiseptic treatment employed be entirely inadequate to cope with the infection, but that it may be more irritating than beneficial to the patient. Moreover, along with the so-called antiseptic dressings, additional infection may be introduced into the wound from the air, from soiled dressings or instruments, or from the fingers of the one who is dressing. Many of these points have received too little consideration. Finally, and more important, is the point, that, as a factor in the treatment of any inflamed process, rest has long since been demonstrated to be a therapeutic agent of great importance. Rest for the wound means infrequent dressing; rest for the injured or inflamed part of the body means protection against movement, relief from muscle spasm, relaxation in correct position—that is to say, efficient immobilization.

Dr. Singer,[1] in her life of Paré, directs our attention to the methods of wound treatment worked out by Paré and by his predecessor, Joubert (1570). Joubert was a skilled medical botanist and a learned physician. Toward the end of his life, he employed pure spring water only as his dressing for wounds. Commenting upon this, Paré said: "As for some empiricks who cure simple wounds merely by application of linen, either dry or soaked in water, and sometimes cure them, it is not necessary to believe there is enchantment, or a miracle, as do idiots and the populace, but merely in the beneficent action of nature, who cures wounds, ulcers, fractures, and other ills. For the surgeon does no more than aid her by removing the hindrance, as pain, flexion, inflammation, and infirmity or other things that cannot be moved by nature alone."

The experience of Paré which led to his simplification of wound treatment is quite generally known. The prevailing treatment for gunshot wounds in his day was cauterization with boiling oil. On one occasion, the supply of oil having been exhausted, he related the following experience: "It chanced on a time, that by reason of the multitude that were hurt, I wanted this Oyle. Now because there were some few left to be dressed, I was forced, that I might seeme to want nothing, and that I might not leave them undrest, to apply a digestive made of the yolk of an egg, oyle of Roses, and Turpentine. I could not sleep all that night, for I was troubled in minde and the dressing of the precedent day (which I judged unfit) troubled my thoughts, and I feared that the next day I should finde them dead, or at the point of death by the poyson of the wound, whom I had not dressed with the scalding oyle. Therefore, I rose early in the morning, I visited the patients and beyond expectation, I found such as I had dressed with the digestive only free from vehemencie of pain, to have had good rest, and their wounds were not inflamed, nor tumifyed but on the contrary the others that were burnt with scalding oyle were feaverish, tormented with much paine, and the parts about their wounds were swollen. When I had many times tried this in divers others, I thought this much, that neither I nor any other should ever cauterize any wound with Gun-Shot."

[1] Singer, Dorothea Waley. Ambrose Paré. London: John Bale Sons & Danielson, Ltd., 1924, pp. 62–63.

In discussing the treatment of compound fractures, John Hunter,[1] calls attention to the difficulty of combining wound treatment with the maintenance of immobilization. He says: "A variety of inventions have been employed to prevent this motion; but the dressing of the wound every day counteracts the effect of every invention that has been thought of, and it is perhaps impossible to dress the sore without motion." It is interesting to note in this connection that the double inclined plane splint in the form of fracture boxes, and a specially constructed bed are suggested in the footnotes by the editor of this edition of Dr. Hunter.

By the work of Hilton[2] (1807–1878) and Thomas[3] (1834–1891) we are taught the control of inflammatory processes by methods designed to conserve body resistance. Hilton and Thomas, better than any others, have demonstrated the tremendous ability of the body forces to deal with infection. Hilton showed over and over again, the value of rest in combating chronic, or, what we might call, low grade infections. He proved that prolonged rest was *the* therapeutic agent of importance. Following Hilton, Thomas was the first to work out a satisfactory method and appliances by which rest could be obtained. With the advent of Pasteur and Lister, we had the opportunity, which, in the mind of the present writer, has never been taken advantage of, to apply the principle of rest to the treatment of the more acute and more severe infections, especially to compound infected wounds of the bones and joints. Lister certainly showed us the way to the prevention and to a certain extent, the control of the putrefactive and parasitic processes resulting from the invasion of wounds by septic microorganisms.

It is now proposed to show that by a successful combination of the principles expounded by Lister[4] with those of Hunter, Hilton, and Thomas, there can be developed entirely adequate methods for dealing with wounds and wound infections.

What has happened in recent practice is, that to a large extent the value of rest in its best sense has been forgotten. Listerism has been construed to demand active chemical antiseptic treatment of wounds. The greatest possible confusion has prevailed as to the methods by which chemical antisepsis is to be obtained.

Keyes, in 1902,[5] was endeavoring to compromise the various methods that had been proposed. Speaking of compound fractures, he said, for example: "The splint should be applied to the limb before the patient leaves the operating table. If the wound is expected to run a clean course a fenestrated plaster encasement is best, reinforced if necessary, by iron bands. If, however, suppuration is feared and daily dressings are expected, such a splint soon becomes soiled and soaked with discharge from the wound, in spite of every precaution.

"The treatment of wounds is of the greatest importance, while the primary irrigation and antisepsis are chiefly to be depended upon to prevent infection, the *irritation as well as the danger of infection from the frequent change of dressings is a common cause of the late suppuration.*" Keyes concludes, however, in the manner common to the practice of the present time with the following:

"If the wound is but loosely sutured and lightly packed in the first place, it may sometimes be left undisturbed until the fourth day. If at the first dressing the wound is clean, it should be disturbed as little as possible. Some of the drainage may be removed. *The wound should not be irrigated.* After this the dressing is renewed at intervals of from forty-eight to seventy-two hours until the wound is healed. If active suppuration occurs *it must be combated by the usual antiseptic methods.*

"If drainage has been used the wound should be dressed at the end of twenty-four to forty-eight hours, and the gauze or tubes removed.

"The appearance of infection in a wound demands the establishment of *free drainage*

[1] Hunter, John. Works of, by James F. Palmer. Philadelphia: Hawell, Barrington & Haswell, 1841.

[2] Hilton, John. Rest and Pain. W. H. A. Jacobson, 5th ed., pp. 514, A. Bell & Son, 1892.

[3] Thomas, Hugh Owen. Diseased Joints, Part II of Contributions to Med. & Surg., pp. 151, 1883; Fractures and Dislocations, Part VI, v. s. 104 pp. H. K. Lewis Co., 1886.

[4] Lister, Sir Joseph. On the Effects of the Antiseptic Treatment upon the Salubrity of a Surgical Hospital, 1870; and A Contribution to the Germ Theory of Putrefaction and other Fermentative Changes, 1875.

[5] Keyes, Edw. L., Jr. Fractures. Woods Ref. Hand Book of the Medical Sciences, 1902.

and the use of antiseptic irrigation. The application of a hot moist antiseptic dressing will often prove beneficial."[1]

The above paragraphs represent the tendencies of wound treatment as carried out by most physicians and surgeons at the present time. Even a clean wound is scarcely permitted to rest and if infection supervenes or exists at the beginning, all considerations of splinting or immobilization (rest) are cast to the winds in the interest of irrigation, packs, etc.

Since the writer began the study of methods and results in the treatment of wounds, he has found it extremely difficult to arrive at any definite opinion or to obtain definite opinions from others in regard to results of treatment. There are thousands of published articles reporting satisfactory results with this method or that in the antiseptic treatment of wounds, but, as statistics are sought with regard to final results with reference to deformity or disability following osteomyelitis, infected fractures or suppurative joints, they are extremely difficult to obtain. Patients are almost invariably discharged from hospital and even from treatment before they are healed, and the final healing with the amount of disability that results, is something for which we can obtain no statistics in ordinary surgical and hospital practice.

At the time of the military draft in 1917, out of the first million and a half men examined, an astonishing amount of disability in the extremities as the result of ununited and mal-united fractures and infections of the bones and joints, was found. Forty-five thousand men, or 2 per cent of all those examined, were found to be seriously disabled on account of these conditions. In the Surgeon General's report the causes were said to be "the liability to accident to which young men are subject often in localities where a good surgeon's attendance cannot be secured." However, the percentage of disability for urban and rural cases does not differ as widely as might be inferred from the above comment. It was found, in fact, that with respect to mal-union of fractures, a condition in which a decided percentage in favor of cities might be expected, no such difference developed. For ankylosis of joints following injury and disease, the comparative percentages are also interesting.

	Urban	Rural
Mal-union of fractures—upper extremity	1.5	1.6
Mal-union of fractures—lower extremity	2.2	2.7
Ankylosis of joints	3.2	3.5

Other observations by the writer seem to bear out the general conclusion that differences in disability following fractures and the treatment of other bone and joint wounds do not arise from differences in skill between individuals or groups in the medical profession, but that the shortcomings in treatment which lead to disability are common to the profession as a whole. These faults as revealed by the present investigation are several; first, the tendency to pay earliest and principal attention to the antiseptic treatment of wounds by pads, packs, irrigations, and the like; and second, to neglect those fundamentals essential to obtaining and maintaining correct length, position, and rest for the injured and infected parts.

Listerism, as applied to the performance of aseptic operations, has been perfected and improved to a remarkable degree. But Listerism as applied to the treatment of infected wounds in general practice nowadays, is scarcely as good as in the days of Lister himself. It must be understood that Lister[2] conceived of antiseptics as a means of preventing rather than controlling putrefaction "for it is hardly needful to point out that neither the spray nor the carbolic acid applied externally, nor the oiled lint inserted in the outlet to serve as a drain could correct putrefactive fermentation once established in the abscess cavity. Here, as in the antiseptic treatment generally, the means are calculated to prevent, not to correct, putrefaction."

Primary asepsis and the protection of the wound for which Lister contended so valiantly, have been to a large extent forgotten in the restless quest for a method or agent which would do what no agent so far has ever done, namely, sterilize an infected wound without damaging the patient.

[1] Italics by the writer of the present article.

[2] Lister, Sir Joseph. On recent improvements in the details of antiseptic surgery. Lancet, London, 1875, March 20, p. 402.

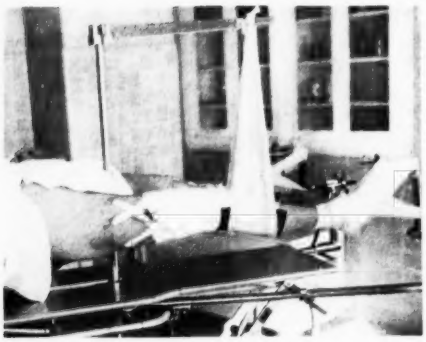

Fig. 1. Case 1. L. H. Condition of patient upon arrival at the hospital. Daily antiseptic dressings for several months. Sequestra, inadequate drainage, etc.

Listerism properly understood and properly applied has conferred countless benefits upon surgical patients and has enabled the surgeon to go far with his operative methods and his surgical technique. Listerism misunderstood and badly applied has, on the other hand, inflicted an immense amount of suffering upon patients with infections and has been responsible for deformity and disability that could have been prevented by less strenuous and more thoughtful treatment.

The following case report (McNamara) is fairly typical of what happens to children with severe acute osteomyelitis. Different writers have given the mortality as from 20 to 50 per cent in such cases. Radical drainage is commonly advised against. It is the opinion of the writer that with the plan of treatment to be described later, the results should be just as good as in acute appendicitis. Early diagnosis, adequate drainage, and rest are necessary.

"M. A. D., aged 10, admitted in the hospital on January 20.[1] The child's mother states that 10 days ago the patient came from school saying she had fallen and hurt her foot. She limped from this time, but until January 22, was able to move about; she was then, while seated in her chair, seized with a violent fit of shivering. The shivering lasted for an hour or so, and recurred again in the evening. During the night the child became delirious. On the 25th she was admitted to the medical ward of the Westminster Hospital as a case of acute rheumatism. On the following day, I was requested to see the child in consequence of the inflamed condition of the left ankle joint. I found the patient bundled up in bed with her knees and thighs flexed; she had the piercing scream of a child suffering from meningitis; her pupils were contracted, her features drawn, almost convulsed, she could not bear the light. The slightest effort to move any of the patient's limbs greatly increased her agony; there were numerous small hæmorrhagic vesicles over the skin covering her chest and abdomen. The patient's temperature varied from 103 to 105 degrees; her lungs were seriously implicated. On examining the left ankle I found a swollen condition of the soft structure over the outer malleolus, extending upward some 2 inches along the shaft of the bone. On passing a grooved needle into the part, pus exuded along the instrument, and I, therefore, made a free incision down to the bone, which was bare of periosteum, and the lower end of the diaphysis was necrosed and separated from the epiphysis. The patient's constant piercing cry was so distressing that she was removed to a special ward. But in spite of the careful nursing and treatment she died within a few days.

"On making a postmortem examination, we found the fibula necrosed and denuded of periosteum for some 2 inches from its inferior extremity, which was separated from the epiphysis. On section the cancellous tissue of the bone was found to be inflamed, with a number of small abscesses extending upward along the interior shaft of the bone. On opening the right and left hip joints, the left shoulder, the sternoclavicular, and the metacarpo-phalangeal joint of the left little finger, we found the synovial membranes extended with pus; the other joints were not opened. On examining the brain, we discovered the membranes to be deeply injected with blood extravasated into the cortical substance of the brain. In the lungs numerous foci of suppuration were observed, and similar infarctions were found in the lining membrane of the right side of the heart."

The points which require emphasis in commenting on an experience like the above are that adequate drainage, antisepsis, and rest have apparently all been neglected. A surgical opening of sufficient size and extent to drain the primary focus in any bone infection is the first indication. In such a case as this, metaphyseal or medullary drainage of the first bone infected is definitely indicated. An attempt to reduce the amount of local infection at the time of operation by a fairly powerful antiseptic is the obvious next step; at that point the teachings of Lister and Thomas may be applied. The primary dressing should be such a one as to prevent further invasion of the wound by septic organisms, and there should be applied suitable mechanical

[1] Vide McNamara, bibliography.

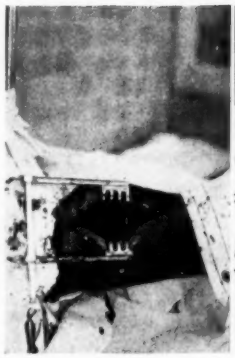

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 2. Case 1. Cavity remaining after removal of sequestra. "Saucerization" or "effacement" of diseased area.

Fig. 3. Case 1. Entire cavity—bone and soft parts—being packed widely open with vaseline gauze.

Fig. 4. Case 1. Cavity and entire wound packed open with vaseline gauze. No stitches are employed.

Fig. 5. Case 1. Final covering with vaseline gauze. This is covered in turn with an absorbent cotton dressing.

devices to put the diseased parts and the patient at rest.

Repeated experiences have confirmed the original observations of the writer that such treatment is just as beneficial in acute infections of bone, whether in primary osteomyelitis or in secondary infections following injuries, as Hilton and Thomas found them to be in the chronic infective diseases of bones and joints with which they report to us so extensive an experience.

In regard to the method of drainage or the type of operation to be employed, it is believed that in the early and very acute cases the simple opening (nearly always through the bone) into the abscess cavity is all that is necessary. The surgical opening, however, must be kept wide open; drainage through a tube or leakage between sutures is insufficient.

McNamara concludes his discussion as follows: "Patients, I am persuaded, have died from not having the inflamed tissues sufficiently incised; but I doubt if a child has ever lost his life in a case of this kind, from the surgeon having made too free use of the knife,"—a sentiment with which the author of this paper heartily agrees. In fact, it is believed that we should go further and say that not only the knife but the chisel should be used more freely in these cases since the common error of the time is to neglect to provide the medullary drainage which is always required.

Starr,[1] of Toronto, has obtained some brilliant results in the treatment of early cases by making drill holes into the ends of the diaphysis and into the epiphysis. This is better than the treatment previously employed because in similar cases previously no drainage whatever had been provided so early for the interior of the bone. It is, of course a fact, that, in very early stages, by making an opening through the periosteum with drill holes into the bone, with drainage and immobilization, a considerable number of these patients will be relieved. The author contends, however, that a larger window into the bone with the wound packed wide open and with adequate immobilization, will provide better drainage, can be done as quickly with no more harm to the patient, and will most certainly arrest the progress of the infection.

Ochsner[2] in an address before the Utah Medical Society states: "Primary operation should consist of splitting the periosteum to and above and below the painful area and lifting 1 to 2 centimeters on each side; as a rule this should be the extent of primary operation. Hot, moist dressings with electric light treatment hasten recovery."

[1]Starr, Clarence. The treatment of compound fractures of long bones. Illinois M. Soc., 1924, June.

[2]Ochsner, A. J. Acute hæmatogenous osteomyelitis. Arch. Surg., 1922, May; California St. J. M., 1924, xxii, 3.

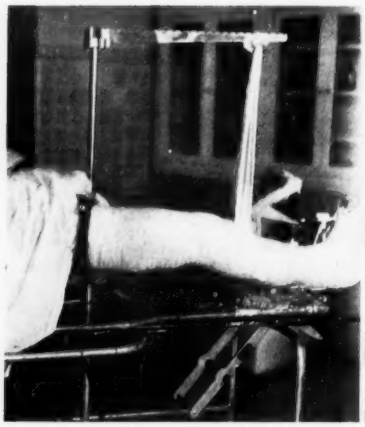

Fig. 6 (left). Case 1. Plaster-of-Paris cast applied to entire limb. In children and some adults a spica or even a double spica is employed.

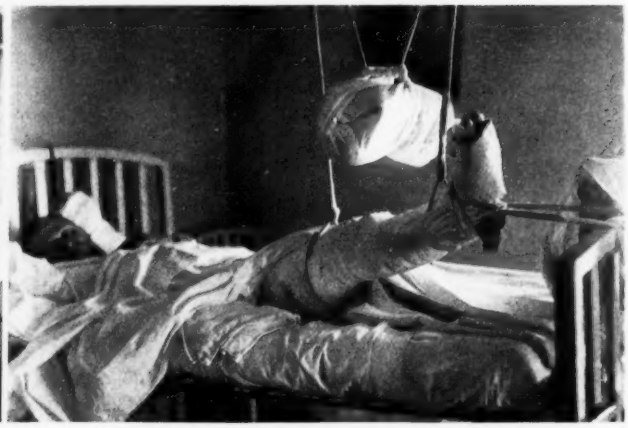

Fig. 7. Case 1. Position of patient with leg cast in bed. When a double spica is employed the foot of the bed is raised and 20 to 30 pounds traction applied to the cross bar.

Dr. C. C. Chatterton of St. Paul, says: "Moist dressings, hypochlorite, normal saline, or boracic acid may be used as aids to drainage but discontinued upon any signs of maceration of the skin. A small catheter may be introduced in the opening and Dakin's method used or tidal wave irrigation with various antiseptic fluids introduced, but hospitalization is necessary in this type of treatment." As I shall show you in a moment, I think this is wrong. Finally, Dr. Dean Lewis refers to this kind of case as follows: "In the acute cases in which subperiosteal abscess has formed, I believe that drainage of the abscess is first indicated. If the fever does not subside and the general condition improve, or there is definite evidence of a suppurative process in the marrow, the cortical bone should be removed and the marrow cavity drained."

Delay in providing adequate drainage for the infected bone areas is a common defect in the treatment of osteomyelitis. The teaching has been prevalent that the bones are not to be opened until sufficient involucrum has formed to give strength to the diseased extremity and until complete sequestrum formation has occurred.[1] There is a certain period in the progress of an osteomyelitis when the advice to wait for this condition to come about may be correct. Too often, however, this counsel has been adhered to for many weeks when the patient suffers during the whole period for lack of drainage.

It is contended that many of the poor results and much of the confusion in regard to present methods is due to a failure to relate and combine the well known principles of asepsis, drainage, antisepsis (at the proper time) and rest.

Tons of antiseptic chemicals and oceans of antiseptic solutions were employed during the Great War for the treatment of wounds. Most of the wounds would have healed without the application of any antiseptic whatever. During the War we employed, to too limited an extent, and too inefficiently, the one therapeutic agent that is absolutely essential—I refer to rest. It is upon rest that the human body depends to a large extent for its ability to withstand and to resist the secondary effects of injury and infection. In open wounds this rest must include not only the relaxation and support of the injured part as a whole, but protection and relief from irritation for the open wound that has been exposed to invasion by micro-organisms. No amount of flooding with antiseptics or of sterilization by irritating solutions will compensate for continuous disturbance of the

[1] Brickner, W. M. Attenuated bone infections. J. Am. M. Ass., 1925, December 25.

Fig. 8.

Fig. 9.

Fig. 8. Case 2. T. T. Showing condition of leg and knee motion at end of one year. Very extreme case.

Fig. 9. Case 3. L. M. Showing bone defect and healed wound in the ordinary acute case—at the end of six months—about six dressings in all. In cast about 3 months.

Fig. 10.

Fig. 11.

Fig. 10. Case 4. End-result of compound fracture in the lower third of the leg at end of 12 months.

Fig. 11. Case 4. R. H. Lateral view of patient shown in Figure 10.

open wound and irritating motion of a compound fracture. Primary cleansing, free drainage, and absolute immobilization are necessary to approximate ideal treatment.

Secondarily, we must have protection of the wound against re-infection and a concontinuous relaxation of the diseased part until healing occurs. It was in an effort to find a combination of factors in treatment that would approximate this ideal that the author was led some years ago to discard practically all of the accepted methods of antiseptic wound treatment in an effort to provide rest for the injured part and subsequent protection for the wound. To summarize: The propositions upon which the treatment of wounds by drainage and rest was worked out are as follows:

1. Primary asepsis or antisepsis to reduce the focal infection (at the point of acute disease or injury). It is not attempted to remove all infection or all diseased tissue. The patient is relied upon to take care of a part of his infection if he is properly assisted and protected.

2. Adequate drainage (wide open to the depths of the infected area).

3. A postoperative dressing or method that will protect the wound and the injured or diseased part so that the wound and the part are at rest and there is no opportunity for re-infection.

4. Immobilize (not simply apply a splint) so that movement, pain, and muscle spasm are entirely relieved, and with all the parts in correct position for recovery with a minimum of deformity and disability.

One of the lessons of the Great War was that most of the splints in common use served perhaps to handicap the patient's movements to some extent, but to immobilize very little or not at all. Moreover, splinting in nearly all cases was made secondary to wound treatment, and splints were disturbed (and are being today) upon the slightest provocation for wound treatment. My experience during the war and since has been similar to that of Osgood,[1] who says: "Plaster-of-Paris dressings with wide openings bridged by hoops of metal or plaster offers the most perfect fixation and greatest comfort to the patient. These are employed in specially difficult and painful cases. Their disadvantages in an English general evacuating hospital, where there are often periods of great rush, are their time consuming initial application and the practical certainty that

[1] Osgood, R. B. Am. J. Orth. Surg., 1917, xv, 668.

Fig. 12.

Fig. 12. Case 5. W. C. Osteomyelitis. Non-union 2 years after a simple fracture of the humerus. Five operations.

Fig. 13.

Fig. 13. Case 5. Six months after Figure 12. Two operations, 5 dressings, 3 casts, body and arm cast shoulder spica employed.

they will be removed when they reach the home hospital."

The lack of attention to splinting for immobilization and the preservation of correct position in these cases is frequently emphasized by demands on the part of patients that some protection be afforded for unstable and deforming extremities. The following quotation from a letter from one of the young officers following his return from France, is typical of many similar complaints that have been made. He says: "The half cast placed on the left leg in France was removed upon my arrival in the United States. I asked that the splints be resumed during the following months as I believed I could feel the foot drawing out of shape. However, no splint or brace was ever used until after I began to walk, when a plate under the foot with braces up the leg was used to take the weight off the foot. A modification of this brace was kept on until the date of discharge when it was removed. I have had no treatment since discharged. I limp slightly and do not know whether the leg is shorter or not; I think it is. At times I cannot place any weight on the foot. The leg is undeveloped; it is a very weak sister."

In the interval between the time of Lister and the Great War the treatment of infected wounds had, if anything, become a little worse rather than a little better. The frantic search for new antiseptic agents left the surgeons confused and uncertain; in fact, almost panicky, when confronted by a large infected wound. The results when we were faced with the situations that developed during the early months of the War were what might have been expected. There was no uniformity either in the matter of antiseptics or methods of application; there was little or no splinting, and except for early and industrious use of such agents as we had, the result would have been much worse than it was.

This is one of the reasons why débridement and the "let alone" policy advocated by the French made such a striking impression; there were a lot of good results. If the same principles had been applied to the wounds

that were left open that were applied to those which it was found possible to close (the principle for which the writer is now contending) the results would have been better still.

Primary asepsis and early protection as taught by Lister; continued protection and rest for the wound and the injured part, as taught by Thomas, are the two outstanding methods necessary to secure results, and these received their vindication during the War.

The attitude of the writer toward these questions began to change during his experience in Great Britain and France in 1917–18. This is indicated by the following circular which he prepared in November, 1918. This was distributed with the approval of the commanding officer of the Savenay Hospital Center and the commanding officers of hospitals at Angers, Nantes, and St. Nazaire, to all ward surgeons. Additional copies were also prepared at the request of Colonel Goldthwaite and sent to other hospitals. This circular in itself tells so much about the orthopedic side of the surgery in Base Hospitals that it is quoted as follows:

Hq. Hospital Center,
Savenay,
28 November, 1918

MEMO NO. 178

The following is published for the information and guidance of all concerned:

By direction of
W. E. Cooper,
Lt. Col., M. C., Commanding Officer
C. S. Adams,
1st. Lt., San. Cps., Adjutant

INTRODUCTORY

Certain data and conclusions resulting from a study of several thousand orthopedic cases at Savenay are submitted herewith as suggestions to the surgical services and the surgeons of this area. This information has been collected at the request of the Consultant in Orthopedic Surgery (H. Winnett Orr, Major, M.C., U.S.A.)

The conclusions reached have been concurred in by the officers whose names are attached (Major Philip D. Wilson and Capt. Leroy C. Abbott). It is believed that the safety and comfort of patients being prepared for and sent on convoys to the United States would be materially improved by an observance of the suggestions following:

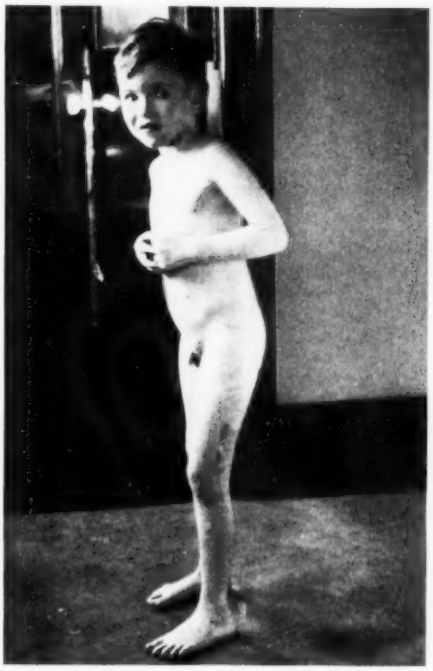

Fig. 14. R. S., Case 6. Condition of patient in January, 1927. Soundly healed and has remained so.

THE TREATMENT OF ORTHOPEDIC PATIENTS IN BASE HOSPITALS

The considerations involved in the treatment of war wounds in Base Hospitals must be made to include not only the existing and imminent surgical pathology but the ultimate position and function of the injured parts as well. It is these latter points which in both civil and military surgery operators have been prone to overlook. A bleeding or infected wound, especially if of considerable size, makes an immediate and urgent demand upon the surgeon's attention. *There has been a tremendous accumulation of evidence in this war to prove, however, that wounds of whatever size and character heal better if all the parts involved are restored immediately to and adequately maintained in as nearly as possible normal anatomical relations.* The different effects of such treatment upon the patient's ultimate career should be almost too obvious to require comment. *It is a fact, however, that not only because of the stress of war conditions, but because of the failure of surgeons to interest themselves in what for convenience must be called the orthopedic viewpoint, many of these patients in Base Hospitals for treatment or in preparation for convoy to the United States have not been dealt with adequately in this regard.*

The long discussion over the relative merits of motion, traction with motion, traction in bed, ambulatory traction, immobilization without traction, etc., fairly indicates the state of mind that has continued with regard to splinting, plaster casts and methods of immobilization of all kinds. Hilton, Thomas, Ridlon, and other sound orthopedic surgeons have never been afraid of rest—in bed or in splints. It is inflammation and the effects of inflammation that are to be feared. All of the immediate and remote effects of immobilization (if properly done) are to be seen in the relief of pain, the reduction of inflammation, the prevention of muscle spasm and deformity and lessening of ultimate disability (ankylosis, contractures, etc.).

Inflammation, on the other hand, if not prevented or controlled, leads inevitably to the adhesion of muscular and tendinous structures, erosion of articular surfaces, and fibrous and bony ankylosis.

"When long continued inflammation has rioted in the tissues of a joint, deforming the articular surfaces and locking them up in organized lymph and shortened ligaments, we have ankylosis, the ultimate degree of which will depend, in my opinion, on the promptness and success of our efforts to arrest the inflammation. And I think that we are wrong when we fear adding to the amount of ultimate ankylosis by early and thorough fixation of the joint. To me it seems reasonable that such a course will diminish the resulting ankylosis by subduing the inflammation and preventing an excess of its products also."[1]

Ridlon[2] was one of the earliest and most intelligent exponents of the importance of rest in the treatment of tuberculous joint disease. All of his arguments apply with equal force to the control of motion, the relief of muscle spasm, and the arrest of inflammatory processes in the treatment of infected wounds. This is particularly true in joint wounds or in those bone and soft part infections that lie in the vicinity of joints. Many experiences in the treatment of severe infections, both acute and chronic, in the neighborhood of the hip and knee have convinced the author that complete immobilization of the parts (double plaster spica) is of the greatest importance in securing recovery for such conditions. Adequate fixation of an acute suppurating knee or hip joint in a well fitting double plaster spica, will not only afford immediate relief to the patient in the matter of pain, but it will turn the tide against the spread of infection, septicæmia, etc., and in favor of the patient. Drainage, is of course, usually important or necessary but immobilization is absolutely indispensable to a rapid and comfortable convalescence.

The author's method for the treatment of osteomyelitis may be illustrated by an account of a typical case.

Miss E., nurse, age 21. This patient developed an acute inflammatory condition in the left foot in January, 1923. The foot was immediately incised but local and general sepsis progressed. Further incisions were made in all parts of the foot and leg following the tendon sheaths and fascial compartments as is customary in such cases. I saw her at the end of the seventh week. She was in serious condition with an enormously swollen leg which had been freely incised and continuously fomented or irrigated for weeks. She had marked hip, knee, and ankle contracture deformity. The foot and leg were badly macerated and very foul because she would not tolerate any cleaning up measures. X-ray at this time showed a destructive bone lesion involving the tarsus which had apparently never been drained. (It may be mentioned that at this time the pain was so severe that she was receiving ¼ grain of morphine every four hours.)

Upon my advice she was taken at once to the operating room and a thorough drainage operation into the tarsus was done. A good sized abscess cavity was found and cleaned out. The wound was packed well open with vaseline gauze and then the hip and knee were straightened out. With a little force the foot was brought up to a right angle with the leg. All of the other open incisions were merely wiped off (or out) with iodine and rinsed with alcohol. A sterile sheet cotton bandage was put on over the gauze dressing and a long cast put on. The patient was put to bed with the leg in suspension and traction. For the first day or two she still clamored for morphine but received none after the third day. At the urgent request of her previous surgeon I did a dressing on the tenth day. There was no discharge and the wound looked healthy. None of the other incisions gave the slightest trouble. This patient was in a cast for 3 months. Then a posterior iron was put on. The wound was entirely healed and has remained so. There is a

[1] Judson, A. B. Med. Rec., 1886, xxxix, 497.

[2] Vide Bibliography.

little equinus and varus deformity but with a special shoe no disability whatever. For the past two and one-half years she reports that she is able to do as much on her feet as she ever did.

The earlier cases treated by the method of drainage and rest did so well, the care of the patients became so much easier and the end-results were so satisfactory that as time went on we were able to go further and further in lengthening the periods of immobilization and non-disturbance of the wound. Not only have very serious wounds healed without much treatment, but highly septic patients have recovered when recovery was not to be expected with ordinary treatment. Distribution of sepsis has certainly been reduced and body resistance to infection has certainly been fortified by this policy of what might be called "extreme rest." Patients with extensive contracture deformities due to muscle spasm have been put at rest in a few hours by very extensive inclusion of the body and the extremities in plaster of Paris. The treatment of the wound both as to primary operation and as to secondary care has been reduced to almost nothing on the proposition that drainage and rest are the only factors of any particular importance. The exact technique worked out during the years immediately following the War was as follows: (See illustrations for Case 1.)

1. Make a fairly large incision over the infected bone area. Spread apart the skin, muscles, fasciæ, and periosteum just far enough to afford access to the diseased area and no farther.

2. Chisel a window into the affected bone area large enough so that all diseased bone may be removed and so that there are no overhanging edges of bone over the diseased area. (Less extensive in acute cases.)

3. Clean out the diseased area gently with a curette or gouge, being careful to refrain from unnecessarily damaging the tissues undergoing repair.

4. Dry the wound and wipe out with 10 per cent iodine followed by 95 per cent alcohol.

5. Pack the entire wound wide open but not tightly with a sterile petrolatum gauze pack. Cover this with a dry sterile pad and bandage on.

6. Now perform any reasonable forcible manipulation necessary to place the parts in correct anatomical position for splinting (abduct the arm to 90 degrees in humerus cases; dorsiflex and supinate the hand in forearm and wrist cases; dorsiflex the foot to a right angle with the leg, in leg and foot cases, etc.)

7. Apply a plaster cast (preferably) or a suitable splint so that the parts are thoroughly immobilized in comfortable and correct position (additional weight and pulley traction, Balkan frame, or even ice tongs or bone pins may be used in these infected bone lesions associated with fractures and old fracture deformities which are being corrected at the same time as the clean up operation.) It may be said that it is in the latter cases that some of the most gratifying results may be obtained by this method.

8. Finally, the cast is not to be split nor are windows to be cut in the cast until the wound dressing becomes necessary. And the *wound is not to be dressed* at all unless there is a rise of temperature or other signs of acute sepsis. As a rule, no dressing is necessary except on account of odor, and this may not be required for several weeks. In a majority of cases the patient treated by this method will go through to complete healing with a few dressings at intervals of from 10 days to 4 weeks.

It may be said that the claims for superiority of the method proposed by the author rest upon empirical rather than upon scientific grounds. There is a lack of the chemical, bacteriological, and statistical evidence commonly adduced in support of contentions of this sort.

In the words of Flexner,[1] however, "There is a widespread impression that the scientific quality of medical practice is in some fashion dependent upon the part played by the laboratory. This is not the case. Science is essentially a matter of observation, inference, verification, generalization.

In considering the technique of treatment by drainage and rest, it is important to emphasize the points that neither partial

[1] Flexner, A, Medicine and Medical Education. New York: Macmillan Co., 1925, p. 5.

closure of the wound by stitches nor tube drainage comply with the requirements as the writer of this paper sees them.

The rubber tube drain not only irritates as any other foreign body will do but serves as an inlet or carrier for infection. The partial closure of such wounds by sutures serves to cover up areas or pockets of infection and militates against sound healing of the wound as a whole. What is desired in such cases is to obtain granulation of a broad surface and a skin covering as in any other superficial wound.

The adoption of the method of wound treatment by drainage and rest meets with certain difficulties because it calls for a change in attitude on the part of surgeons toward this entire problem. The technical methods proposed although differently arranged, are not new. Moreover, from the standpoint of most of us, our methods, heretofore, have given us generally quite satisfactory results; in other words, we "get by" very well. There has been, however, a much larger percentage of unsatisfactory results than we realize. Because the patients do not complain very much and because our work is as good as the average, does not indicate that we may not do much better.

I am reminded of a patient who was limping out of the hospital at the end of the seventh week following what should have been an aseptic appendectomy. She thought she had the best surgeon in the world, because, although she had become infected at the time of operation (which she did not know) he had dressed the wound himself twice daily for the 7 weeks, and she had finally recovered. Many of our cases of osteomyelitis pursue a course like this or worse, and because life and limb are saved they think they have had the best possible surgical treatment.

Since the War period, more and more emphasis has been placed upon the surgical operation in chronic osteomyelitis. In chronic osteomyelitis, the operative method referred to by Ryerson as "saucerization," or by Mebane as "effacement" is the ideal procedure. This has the effect already referred to of converting a deep pocketed bone abscess into a superficial wound, healing occurring evenly from the bottom up and giving us much greater freedom from subsequent complications than has been customary heretofore.

Since the "rest treatment," as described by the author was first proposed, one of the commonest questions asked has been with regard to his attitude toward acute cases. There are several important points that require consideration in the discussion of this matter. In the first place, the disposition, heretofore, has been to employ methods that provide a minimum rather than a maximum of drainage. The popular methods have been those of an incision through the periosteum, drill holes into the medulla and into the epiphysis only, and other procedures that might be called minimum rather than maximum.

There are in literature numerous assertions by competent observers to indicate that, if not at once, at least very early in practically all cases, there is pus in the bone marrow. It has also been pointed out that drainage into the bone marrow in early cases will do no harm if pus is not encountered. We have had several illustrations of this point. In Case 3, an opening was made into the bone marrow and no pus was found. This case healed almost without drainage. It was significant that in this case pain, swelling, and other symptoms including a marked leucocytosis were markedly relieved within 48 hours. In this patient healing took place within a few months and she has had no recurrence.

Among the advantages which should be emphasized for the treatment of these conditions by drainage and rest alone, none is more important than the relief afforded the patient.

In children especially, the infrequent dressings following an operation for osteomyelitis, make the greatest possible difference not only in reducing the amount of suffering but in an improvement as to rest, appetite, and general condition. Even adults who stand frequent dressings fairly well are much more comfortable and seem to do better because of the relief from frequent disturbance of the wound.

If dressings are done at intervals of several weeks, instead of daily, it is quite possible for the surgeon to give the necessary time to see that his original ideas in regard to the position of the limb, splints, apparatus, etc., are strictly carried out and to have the dressings done under his own eyes so that proper rules of technique and after-care are strictly observed.

All of these are matters of the greatest importance which, in using ordinary antiseptic methods have been neglected or overlooked. By the simple method of drainage and rest as described, all of these points can be kept in mind and constantly observed.

The different effect upon the wound itself is shown by the fact that upon examining the wound for the first time two or three weeks following operation, there is found to be usually less discharge than is found at each dressing when they are changed frequently. This seems to explain why the absorption is less also when the infrequent dressing method is employed.

Naturally, there is a great saving in materials and labor; both the hospital and the attendants benefit by the fact that dressings are done at intervals of several weeks instead of daily or every few days. Furthermore, when dressings are done infrequently it is possible for the surgeon himself to become responsible for the postoperative care of the case. It has been entirely too common for the surgeon, immediately following operation in such cases, to shift the after-care to other and less capable persons.

In the chronic cases, the dressings often get so far away from the surgeon himself that they are done by untrained hospital attendants or even by the patient himself or some member of his family. Secondary mixed infection has therefore been the rule, and the end results in such patients are almost certain to fall far short of what the surgeon had in mind at the time of operation.

Several surgeons who have employed the technique described by the author in the treatment of these cases have made the observation that, whereas the course of the disease following operation and immobilization is very favorable, there is sometimes considerable delay in securing final healing in the late stages of the condition. A careful inquiry into the details of treatment in such cases reveals two important things. First of all, the patients themselves are seldom kept at rest during the late stages of these conditions. As soon as they begin to feel well enough they are allowed to be up and about with limbs hanging down and usually with a reduction in the amount of immobilization. It has been the author's opinion that activities of this sort delay healing and cause a considerable amount of swelling and congestion of the part. This swelling goes down at night and recurs next day. This alternate swollen and congested condition of the diseased area of a lower extremity, for example, certainly interferes with its repair.

It has also been noted that at this stage of the procedure, it is very common to permit some less experienced person to do the dressings. Dressings are also being done more frequently and a wound which has been kept fairly clean and at rest up to the end of 2 or 3 months, immediately takes on a different aspect with an inflamed, irritated surface due to the dressings having been changed by inexperienced persons.

The combination of these two things—decreased immobilization and an increased number of less sterile dressings—will serve to reduce any case to the condition in which these patients have almost always been found, namely, with chronic mixed infected wounds which are slow in healing or which do not heal at all. Such infection may, and usually does, penetrate into the deeper tissue of bone and give additional trouble where sound healing might have occurred if the principles enumerated above had been strictly adhered to.

Table I shows the results in a series of consecutive cases. Many recent cases are omitted as being incomplete.

Just as lives and limbs were saved on the battle fields of France by early immobilization of gunshot fractures in Thomas splints, so there is an opportunity to rescue those who are acutely infected with osteomyelitis, arthritis, and fractures, by prompt fixation in casts or other suitable devices. Drainage

TABLE I.—RESULTS IN A SERIES OF CONSECUTIVE CASES

	Diffuse	Local	Compound fracture	Chronic	Preliminary operation	Operation and rest	Second operation	Under treatment	Not traced	Cured	Failure	Died	
W.C. 1		x			x	x	x			x			
L.A. 2		x	x			x				x			
P.C. 3			x			x				x			
F.C. 4		x	x		2	x	x			x			
C.H. 5			x		x	x				x			
D. 6		x			x	x	x						
H.D. 7													
M.E. 8		x		x	x	x				x			
F. 9		x				x				x			
G. 10		x							x				
H. 11		x	x	x	x	x	x			x			
H. 12			x	x		x	x	x	x				
H. 13	x					x				x			
E.H. 14		x		x						x			
K. 15		x		x		x				x			
C.K. 16		x	x			x	x						
K. 17		x	x	x	x					x			
L. 18		x							x				
L.M. 19		x				x				x			
V.M. 20		x	x	x	x	x				x			
M. 21		x				x				x			
McC. 22		x	x			x				x			
E.A.M. 23		x		x	x	x				x			
O.M. 24		x		x		x				x			
L.M. 25		x				x				x			
P.M. 26		x	x			x				x			
L.M. 27		x					x	x					
R.O. 28		x	x		x	x	x			x			
P.P. 29		x		x	x	x		x					
B. 30		x				x				x			
P. 31		x				x				x			
R. 32		x				x				x			
A.R. 33		x		x		x							amputation
S. 34		x				x				x			
E.J.S 35			x				x			x			
E.S. 36		x				x				x			
D.M.S 37		x		x		x							amputation
S. 38		x	x	x		x				x			
S. 39		x		x	x	x				x			
R.S. 40		x	x		x	x			x				
F.S. 41		x	x	x	x	x	x			x			
F.F.T. 42		x				x				x			
T.T. 43	x			x	x	x	x	x					
M.T. 44		x				x				x			
R.Z. 45			x			x				x			
E. 46			x			x				x			
T. 47	x			x		x				x			

is a matter that will often (but not always) take care of itself. If nature is left to do her own immobilizing, life may be preserved, but contracture, deformity, and disability are invariably the result. Early, simple drainage (but thorough), protection against bacterial invasion, and fixation in correct position, are the principles of treatment for which adequate methods must be employed.

Our further development of a perfect and applicable technique must not be abandoned until our results are far better than are now being obtained.

ILLUSTRATIVE CASES

CASE 1. L. H. H. This patient sustained a fracture of the right femur in the middle third, on March 22, 1926. He was removed at once to a hospital in a town 18 miles away. Several expedients were tried in an effort to place the fragments in correct position and to secure adequate traction. These having failed, an open reduction was decided upon and this was done on the eighth day. A Lane plate was applied but a traction table was not available and satisfactory position was still not obtained and the plate proved to be inadequate to control the position of the fragments. Furthermore, an infection supervened and in a few days the patient was in great distress both because of failure to control the fracture and a rapidly increasing local and general infection. At this point, the patient came under the care of the writer. A traction device was taken out to the patient (about two hundred miles) who was thought to be too sick for transportation. The patient was placed upon the traction table under ether, and ice tongs were inserted into the condyles of the femur. Under strong traction upon both the foot and the ice tongs, the leg straightened out and came down to full length. The wound was opened up widely, the steel plate was removed and with a small chisel used as a pin, the fragments were brought into correct position. The chisel was driven in to secure the fragments during the application of the cast. Now the wound was wiped out very thoroughly with tincture of iodine and alcohol and packed with vaseline gauze. A dry gauze dressing was placed over the pack and a double spica cast put on. The patient was kept in bed with the foot of the bed elevated and instructions were given not to open the cast or disturb the dressings except for temperature, swelling, or other signs of inflammation. About ten days later, however, there was some drainage showing through the cast and a little odor; so it was opened up and daily dressings begun. Thereupon, the temperature which had come down, rose again and the discharge increased.

Following a telephone conversation, the patient, was transferred to Lincoln, making the trip, in his cast, without much discomfort. The wound was cleaned up, repacked with vaseline, a cast applied, and a policy of better immobilization and rest for the wound faithfully carried out. The local inflammatory and general symptoms quieted down and the wound went along to nearly complete healing. Solid union of the femur occurred. On June 30, 1926, the man was permitted to return to his home on furlough although it was pointed out to him

that there were one or two sequestra forming which would require removal later. Those sequestra have now been removed, the patient's general condition is excellent and he is recovering with a straight limb not more than one-half inch short. (See Figs. 1 to 7.)

CASE 2 T. T. I was called in consultation to see this boy after one month's illness in the hospital. He was in desperate condition with an extensive septic involvement of the entire leg extending to the knee. There was tremendous swelling of the limb as high as the hip and the boy was acutely septic. I was called in to decide the question of amputation and promptly advised against it as it was evident that amputation would cost the boy his life.

An extensive drainage operation for the foot and entire leg was done the same day. Previous drainage had been afforded only by incision through the skin and the soft tissue. Large windows were made in the bony structure of the tarsus and in the upper and lower ends of the tibia. A large sequestrum in the tibia was not removed until later. The wounds were packed wide open with vaseline gauze and the entire limb put in a plaster cast. The limb was put in suspension and traction at once.[1]

At the time of operation the entire leg was full of pus. For the first few weeks drainage was very profuse; at the same time dressings were very infrequent and the packs were not removed oftener than at intervals of from 2 to 4 weeks.

This boy was slow in recovering but left the hospital in about 10 weeks and since that time the wound has been dressed about once a month. He has had four or five changes of cast and is now wearing a caliper splint.

The photograph shows the condition at the end of 12 months. Both the leg and tarsus are practically healed at the present time. Attention is called to the range of motion in the knee which is within a few degrees of normal, this in spite of 8 months in a plaster cast.

The boy is now returning to school and gives every promise of having a useful limb. (Fig. 8.)

CASE 3. L. M. This patient came under my observation May 22, 1926. She had sustained an injury to the knee 6 weeks previously. The knee was considerably swollen. X-ray showed an area of destruction in the upper end of the tibia near and under the tibial tubercle. There was much tenderness and thickening at that point but no fluctuation. The knee was operated upon the next day and a softened area the size of a large olive was found on the inner side of the upper end of the tibia leading down into the head of the bone. This was opened widely but not curetted. The wound was packed wide open with vaseline gauze and the limb placed in a plaster cast, and was not dressed for one month.

[1]I consider it desirable to employ suspension in a Balkan frame and traction by means of weight and pulley for all patients with lower extremity osteomyelitis when it is undesirable to use a double plaster spica or a body cast. In small children or in patients difficult to control the double spica is to be preferred. In the upper extremity in children, it is desirable to use the body and arm cast with the arm in abduction, the elbow flexed and the hand supinated. The ordinary aeroplane splint or recumbency with the Blake suspension device may be used.

The pain from which she had been suffering severely was relieved immediately and has not returned. The patient was highly neurotic and complained considerably about the cast which, however, was kept on for 3 months. After the third dressing the cast was removed and left off. In September the wound was pronounced healed and has remained healed. There is slight limitation of motion remaining, but she walks about attending to her housework and seems to be making a complete recovery. There is no return of inflammation, swelling or pain. (Fig. 9.)

CASE 4. R. H. This patient sustained a compound comminuted fracture in an explosion of a compressed air tank on December 1, 1925. The fracture was in the lower half of the tibia and fibula, and there was a considerable amount of comminution and deformity. The accident occurred on the day when the Central States Orthopedic Clinical Society was meeting in Lincoln and he was operated upon in the presence of some of the members.

Traction was applied on the Hawley table with a pin through the calcaneum. The leg was brought down to full length, the wound was cleaned up. No fragments of bone were removed as the small pieces were found firmly attached. The wound was allowed to remain open, however, and gently packed with vaseline gauze. No dressing was done until December 30, 1925. A little later X-ray showed that there was some lateral displacement of the fragments. A pin was introduced through the skin, the fragments manipulated into nearly correct position, and the pin was driven into the lower fragments, and the cast renewed in such a way as to hold the pin and fragments in this position.

During the next 2 months dressings were done twice, the pin in the meantime having been removed. All wounds were soundly healed at that time and there was beginning but not solid union. Complete bony union was somewhat delayed and the leg was not considered to be solid until after about 6 or 7 months. At about the seventh month he returned to work, not as a machinist but as a shoemaker, walking to and from work with the aid of a double lateral iron on his leg, and crutches. He has continued to improve, the swelling of the limb has almost entirely subsided, and at the end of the eleventh month he is solidly healed in very good position.

There is a small amount of shortening due partly to the bone defect and to the fact that exact approximation of the fragments could not be obtained. He has good ankle motion and weight bearing joint for the foot, and the leg is about 95 per cent mechanically correct. There is slight pronation of the foot due to a spreading of the leg bones at the ankle joint which could not be entirely controlled. This is corrected in walking by means of an inside wedge on the heel. (Figs. 10, 11.)

CASE 5. W. C., age 19. This patient sustained a simple fracture of the lower third of the humerus in March, 1923. The first treatment failed to give

union and four times in 1924 and 1925, operations were performed. Three months before coming to the hospital in Lincoln, another operation was performed and the fragments strongly wired together. Infection unfortunately followed this last attempt and when seen by us there was not only non-union and some deformity, but a stiff elbow and an osteomyelitis involving the entire lower half of the humerus. The patient was in poor general condition.

Our operation (September 18, 1925) consisted of removal of all the wire and two sequestra through a generous incision. The entire wound was packed widely open with vaseline gauze and a body and arm cast put on with the arm well abducted, the elbow flexed and the hand supinated. Following operation, the wound was dressed and he was permitted to return to his home in Kansas. Four weeks later he returned for another dressing. The wound was almost healed and about 6 weeks later was found quite healed. While in the cast there seemed to be some improvement in stability at the point of fracture and it was determined to stimulate bone production by chipping off a few fragments at the end of the fracture fragments. Through a window in the cast and subcutaneously (outside the scar area) a small chisel was inserted down to the fracture region and with a mallet a few pieces were chipped off and placed in the space between the ends of the bones. As expected, a certain amount of inflammation followed and a small abscess formed which pointed near the olecranon. This was incised and drained and healed in a few days. To our great interest, we found at the end of the next 6 weeks that definite callus was forming and on April 16, 1926, the cast was removed and good union was found to have occurred. A splint was kept on until December 18, 1926, but at the present time the young man is doing light work and using the arm to drive a car and for many other purposes. It is expected that later on, an arthroplasty of the elbow can be done to restore motion to the elbow. There has been no recurrence of the inflammatory process. (Figs. 12, 13.)

CASE 6. No. 7005, R. S., age 6 years. This child came 250 miles on the train and was admitted to the hospital September 1, 1926, with a temperature of 105 degrees; pulse, 140; respiration, 32; white blood count, 28,000. There had been pain in the knee and thigh for 3 days previously. Hot packs had been used to allay the discomfort but during the last 24 hours, the least movement of the left lower extremity caused severe pain. The temperature when last taken 12 hours before admission to the hospital was 106 degrees and had been 104 degrees the day before.

The lower third of the left thigh was swollen and tender. There was a definite redness radiating to the outer side of the front lower portion of the thigh. Movement of the knee or hip caused severe pain. The child was negative as to other physical findings except for mild furunculosis on the back of the neck and infection of one finger. X-ray findings were negative as to any bone lesion.

The child was taken to the operating room with a diagnosis of acute osteomyelitis of the lower third of the femur. (Operation by Dr. J. E. M. Thomson, Dr. Orr consulting surgeon.) An incision was made laterally just behind the quadriceps group about 6 inches long. The skin, muscles and periosteum were reflected and a small chisel hole made in the cortex of the metaphysis just proximal to the epiphyseal line. Immediately a yellow, creamy pus welled out. The opening in the bone was extended to about 3 inches long and one-half inch wide so that the entire lower third of the femur was well drained.

Pus exuded freely and was apparently under pressure. Very little curetting of the medullary cavity was done and the wound was filled to the depth of the medulla with a vaseline gauze pack and a double plaster-of-Paris spica cast was applied. In 12 hours his temperature had dropped to 99 degrees; it went up in the afternoon to 101 degrees, but was down the next morning. The temperature ranged within these limits for 3 days; after that the temperature remained under 99.6 degrees for 4 days, after which he had a normal temperature, once or twice rising to 99 degrees and a fraction.

At the end of 6 weeks, the cast was removed and the dressings taken out. There had been considerable drainage under the cast but upon removal of the vaseline pack, the wound had filled in to practically one-half the previous depth and was covered from the base with healthy granulation. A new single spica cast was put on and worn for a month longer, when it was removed and the wound was found to be healed with the dressings pushed entirely out of the wound and the serum which had come from the wound entirely dried.

This wound which had gaped open originally about 2 inches, is now closed to less than one-half inch at the widest portion of the scar. He was placed in a double lateral iron brace and physiotherapy, massage, active and passive motion instituted. Since he has been up and around he has had no temperature and is now (January 10, 1927,—date of photograph) apparently entirely well.

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MESENTERIC LYMPHADENITIS SIMULATING AN ACUTE ABDOMINAL CONDITION[1]

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TUBERCULOSIS of the mesenteric lymph nodes, tabes mesenterica, was recognized as a clinical entity by the German and French writers in the early part of the nineteenth century. The clinical picture, as given by these writers, is confused, and undoubtedly includes many cases of tuberculous peritonitis, malnutrition, and rickets.

In 1895, Maurice Richardson of Boston first successfully removed tuberculous ileocæcal glands found at operation. In 1899, J. W. Elliott and Marchant also described the operative procedure for this condition. The classification of retroperitoneal lymphadenopathy received little careful study until 1919.

FREQUENCY OF OCCURRENCE

Statistics of the occurrence of glands noted at abdominal exploration, gathered from numerous surgeons, show a wide variation in the percentage and it is only within the last 7 years that careful search for retroperitoneal lymphadenopathy has been made at the time of exploratory laparotomy. When surgeons are on the lookout for the presence of diseased glands, larger numbers will be demonstrated.

Most authors agree that, in the greater number of cases, retroperitoneal tuberculosis and lymphadenopathies of questionable tuberculous origin, are diseases of early childhood and young adult life. Corner believes that tuberculous mesenteric glands are to be found in practically every child upon whom an abdominal operation is necessary. Risley believes the disease to be extremely common in infancy and childhood, but by no means confined to this period, being nearly as common in young adults. He notes that the highest incidence is found in patients between the ages of 16 and 18 years. Floderns, Gersets, and Struthers found most of their reported cases of mesenteric lymphadenitis in children and young adults.

The autopsy statistics of Eisenhardt, Ronseff, and Harnan, on persons who had suffered from pulmonary tuberculosis, show from 50 to 68 per cent occurrence of retroperitoneal tuberculosis. In fifteen thousand post mortem examinations, Keiler found tuberculous retroperitoneal glands in 1 per cent. Bertzke presented similar figures. Osler and McCrae state that Bovaird, at the Mt. Sinai Hospital, New York, found the incidence at post mortem to be less than 1 per cent, while John Thomson reports it as 3.54 per cent for Edinburgh and 4.51 per cent for Glasgow. Opie finds a much lower incidence in St. Louis.

The above figures substantiate Braithwaite's assertion that different localities and countries have a greatly varying percentage in the incidence of retroperitoneal tuberculosis. He finds the disease more common in his private than in his dispensary practice.

ETIOLOGY

In 1917, Frankel stated that intestinal tuberculosis was rare in infants (9 months to 1 year old) but gradually increased in frequency to the fourth or fifth year and then diminished again. This term coincides with the average time of weaning and the change from mother's milk to the diet through which contaminated food has an opportunity to invade the intestinal canal.

Braithwaite has definitely traced the use of infected milk as a cause for the disease in a number of his patients. Shrota, reporting 24 cases from Japan, makes the interesting observation that none of the patients had drunk milk.

It is generally accepted that there is a higher percentage of incidence of the bovine type of the organism. The bacilli are taken into the intestinal canal in milk or milk products from tuberculous animals. The human type is usually acquired by sputum

[1]From the Department of Surgery, Woodland Clinic.

being swallowed by persons suffering from pulmonary tuberculosis.

MODE OF ENTRY OF INFECTION

The factors causing the ileocæcal region to be more susceptible to the entry of micro-organisms of tuberculous or non-tuberculous origin are: stasis, distention of the bowel, catarrhal inflammation, mucous abrasions and lowered resistance of the surface epithelium caused by bacterial toxins. Carson believes that infection occurs through a breach in the intestinal mucosa and the lowered resistance of the mucosa from previously existing toxins and general sepsis. Walsham, Philip, and Morley are inclined to believe that infection may pass through mucosa which is intact or may arise from primary ulcers in Peyer's patches.

There seems to be an exact analogy between the anatomical arrangements and relationship of the cervical lymph nodes and the lymphatic apparatus of the neck and those of the mesenteric glands and the intra-abdominal lymphatic apparatus. In both the pharynx and the wall of the terminal ileum, masses of lymphadenoid tissue have collected, which, in the neck, are tonsils, and, in the terminal ileum, are the Peyer's patches. In either instance the lymphadenoid collections in the wall of the alimentary canal (tonsils, Peyer's patches) form the first point of blockage and filtration of the lymphatic stream and the cervical and mesenteric nodes form the second points. It is assumed that Peyer's patches, like the tonsils, form the point of entry for the infecting bacteria. For some unexplained reason, the glands closer to the source of infection apparently are more resistant to the organisms even though they are closer to the site of the septic invasion. The smaller glands do not function in straining bacteria from the lymphatic stream to the same extent as the larger.

Pagenstecher states that the order of incidence is: first, ileocæcal glands; second, those at the root of the mesentery; third, those of the ascending colon; and fourth, those of the sigmoid. The glands at the root of the mesentery receive most of the lymphatic drainage and are for that reason, frequently infected (Figs. 1, 2, 3).

PATHOLOGY

The pathological process of the proved tuberculous lymph nodes is similar in every respect to the tuberculous lymph nodes in other parts of the body. The findings at any certain time are dependent upon the stage of the process and the course is governed by the ratio between the virulence of the organism and the resistance of the individual.

At the present time there are differences of opinion among various authors as to whether the tubercle bacillus is the etiological factor in all the cases of mesenteric lymphadenitis which simulate an acute abdominal condition. Symmers states that tuberculous lesions in the intestine and elsewhere are capable of producing simple hyperplastic changes in the mesenteric lymph nodes without the occurrence of tubercles, these hyperplastic changes being caused by the absorption of toxins from the ulcerated gut or Peyer's patches. Walsham, Philip, and Morley concur in this opinion.

Wilensky has recently raised the question as to whether mesenteric lymphadenitis which, after pathological study and laboratory tests showed no evidence of tuberculosis in the excised gland, might not be due to pyogenic infection other than tuberculosis.

Struthers feels that most cases of mesenteric lymphadenitis in which the tubercle bacilli have not been demonstrated are nevertheless caused by reactions provoked by the invasion of that organism.

Braithwaite believes the tubercle bacillus to be the infecting organism in all cases of mesenteric lymphadenitis. He divides the clinical picture into five classes, considering the first class as simple hyperplasia without demonstrable tubercles or bacteria; the intermediate classes represent the progress from hyperplasia through suppuration, caseation, and final calcification.

Wilensky divides the process into (1) simple mesenteric lymphadenitis, (2) suppurative mesenteric lymphadenitis, (3) tuberculous lymphadenitis, and (4) the terminal stage of mesenteric lymphadenitis.

It is unfortunate that, in most operative cases careful pathological and bacteriological examinations have not been made. Heusser, in a report of 40 cases, finds a certain number of the simple hyperplastic glands in which no tubercle bacilli can be demonstrated by guinea-pig inoculation, cultures, or use of the antiformin method.

Suppurative mesenteric lymphadenitis does not occur in acute appendicitis, enteritis, colitis, typhoid fever, or secondary to intestinal parasites. We are therefore confronted with a definite group of cases occurring to the greatest extent in childhood and early youth, the greatest percentage of which can be definitely proved to be tuberculous infections. At the time of exploration, several patients have had a diagnosis of hyperplasia. At a later date caseous glands have been removed.

Therefore, until proved otherwise, it is logical to assume that they are all reactions provoked by an extension of tuberculous infection. In these cases of simple hyperplasia, if the existence of tuberculous infection is to be definitely proved, numerous glands must be excised and subjected to careful pathological and bacteriological study. Very few surgeons wish to subject their patients to unnecessary risk by the excision of numerous glands or by opening the bowel to look for primary ulcerations in the mucosa. The absolute proof can seldom be assured. The assertions of Braithwaite and Symmers that these hyperplasias are due to toxic absorption from ulcerative tuberculous lesions in the mucosa are the most logical.

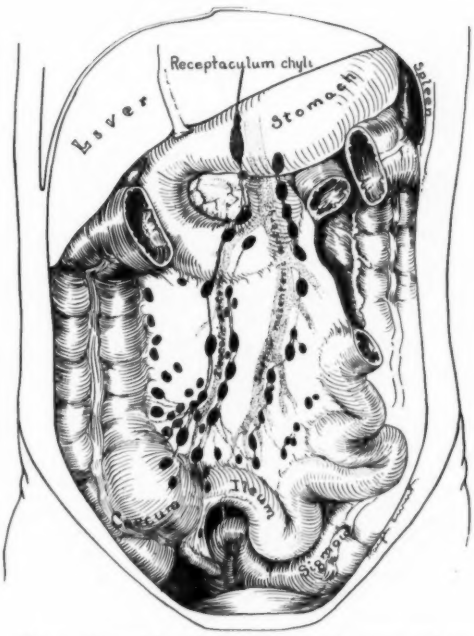

Fig. 1. Normal lymphatic drainage of cæcum and terminal ileum, illustrating the cæcal drainage and the greater portion of the small bowel. The lymphatic drainage empties into the receptaculum chyli at the level of the second lumbar vertebra. The black areas represent the superficial and the grey areas the deep glands.

SYMPTOMS

It is impossible to establish a definite clinical picture. This disease presents the characteristics of an acute abdominal condition and is best described as acute, and chronic with acute exacerbations. The resistance of the individual to tuberculous invasion is the factor which determines the outstanding symptoms.

Acute mesenteric lymphadenitis usually has a sudden onset with tenderness and rigidity of the abdominal muscles more pronounced over the right lower quadrant. Vomiting usually ensues. The pulse count is 100 to 120 and the temperature varies from 100 to 103 degrees F. The white blood count will be found to vary from 12,000 to 15,000. In the less acute cases there is moderate tenderness over the right iliac fossa with less systemic reaction. The pain experienced is usually paroxysmal in type, is severe enough to double the patient up, and cause him to cry with pain. It lasts about 5 minutes, recurs 2 to 5 times daily and stops suddenly. During the intervals, the patient is usually comfortable. Carson believes that the pain is caused by a reflex spasm of colic incited by irritation of the vagus filaments in the mesentery.

The general impression given is that of a severe systemic reaction without the marked physical findings which one would expect. The acute symptoms usually subside in 2 or 3 days.

Fig. 2. Mass of glands around cæcum and terminal portion of ileum.

In the chronic forms the initial symptoms are usually pain, intermittent in character, which may be vague and transitory, colicky and recurrent, or of the drawing and dragging type. The pain is usually on the right side, although it may be anywhere in the abdomen. Vomiting is often a symptom. Chronic forms very often have acute exacerbations caused by superimposed secondary infections which lower the patient's resistance. Risley, in a review of the records of 65 cases in which tuberculous mesenteric glands were found at autopsy, found that none of the patients in this series had complained of abdominal pain as a symptom. These findings would lead one to believe that many individuals are infected in early youth, but overcome the infection without the toxin absorption having caused more than hyperplastic changes in the glands. If the tuberculous infection has gained sufficient foothold in the tissues of its host and a partial immunity is established, its progress is arrested or very appreciably slowed. A lowering of resistance by general or chronic systemic infection may activate the dormant process. The clinical picture then becomes one of recurring periods of activity with acute abdominal symptoms.

The patient is often undernourished and appears subnormal as to strength and endurance, is usually anæmic and listless and has a poor appetite. However, quite an appreciable number show very little physical sign of weight, strength, or appetite loss.

Fig. 3. Mass of glands at root of mesentery of small intestine with a few enlarged glands in mesentery of descending colon.

Different authors have reported masses of variable sizes as palpable in the right lower quadrant. In our series, we have not been able to substantiate this as a diagnostic symptom. There is usually a daily rise of temperature in the afternoon and there may be evidence of other tuberculous foci, such as enlarged cervical glands, scars on the neck, tracheobronchial lymphadenitis or signs of latent or active pulmonary lesions.

The secondary complications may be those of ileus; caseation; abscess formation, sometimes with rupture; disturbances from pressure on other organs; and miliary tuberculosis. Hæmorrhage, mesenteric thrombosis, and obstruction of the common bile duct are rare.

DIFFERENTIAL DIAGNOSIS

In children and young adults suffering from retroperitoneal lymphadenitis, it is often impossible to make a diagnosis other than that of an acute abdominal condition. An X-ray diagnosis can sometimes be made if the glands are caseous or calcified. When the condition is acute, the diagnosis is occasionally suspected but is seldom positive because of the very striking resemblance to acute appendicitis. In children, appendicitis, pyelonephritis, Meckel's diverticulitis, acute, and intussusception are usually considered. In young adults and adults, chronic appendicitis, gall-bladder disease, pyelonephritis, and intestinal or peritoneal tuberculosis are to be considered. There is no disease quite so

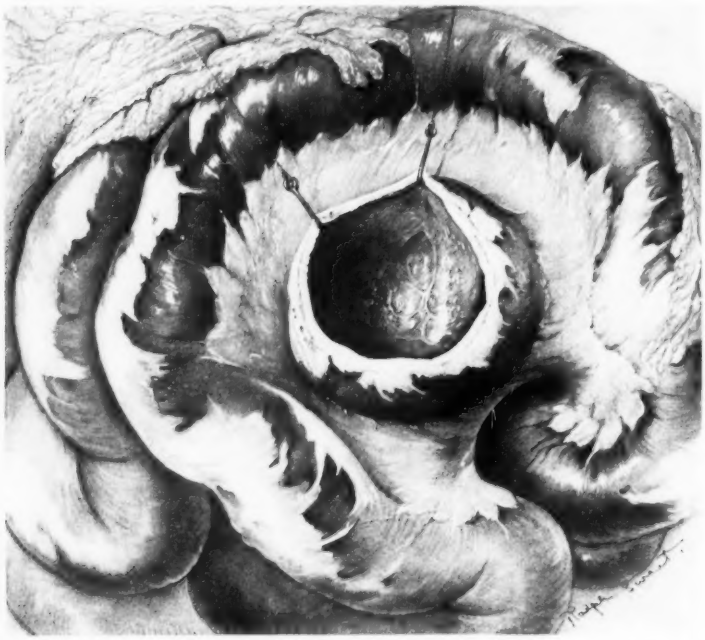

Fig. 4. Ruptured tuberculous abscess in root of mesentery of small intestine of the upper jejunum. Marked fibrinous peritonitis.

treacherous as acute appendicitis, especially in children. Delay in exploration of the abdomen may cost the patient's life by rupture of the appendix. For this reason, immediate exploratory laparotomy is imperative if acute appendicitis is suspected.

TREATMENT

The treatment may be medical or surgical after a definite diagnosis has been made. In relatively few cases is this achieved before exploratory laparotomy. The pathological complications are so varied that abdominal exploration should be resorted to in all cases.

The medical treatment in our series of cases has consisted of high caloric diet, rest, and out of door life. Quartz mercury lights are used for the anæmic patients suffering from the chronic form of mesenteric lymphadenitis.

Opening the abdomen apparently has a beneficial effect as the greater number of patients promptly regain their health. Those who have recurring attacks, with acute exacerbations, are given X-ray treatments. Such treatments are of great value in the treatment of tuberculous cervical lymphadenitis before suppuration has occurred and it is reasonable to believe that such therapy is indicated for cases of marked mesenteric lymphadenitis, without suppuration or caseation. The use of tuberculin is, as a rule, of little value. Abscessed and caseous glands should be incised, curetted, and their walls enfolded (Fig. 5).

REPORTS OF ACUTE CASES

Because of the number of cases (14 in both groups) and the space their reports would occupy, only those illustrative of the types of mesenteric lymphadenitis will be given in detail.

CASE 2. G. R., female, age 9, entered the hospital on September 20, 1926, with the complaint of pain in the abdomen and nausea. At the age of 8, she had had influenza, lasting one week, complicated

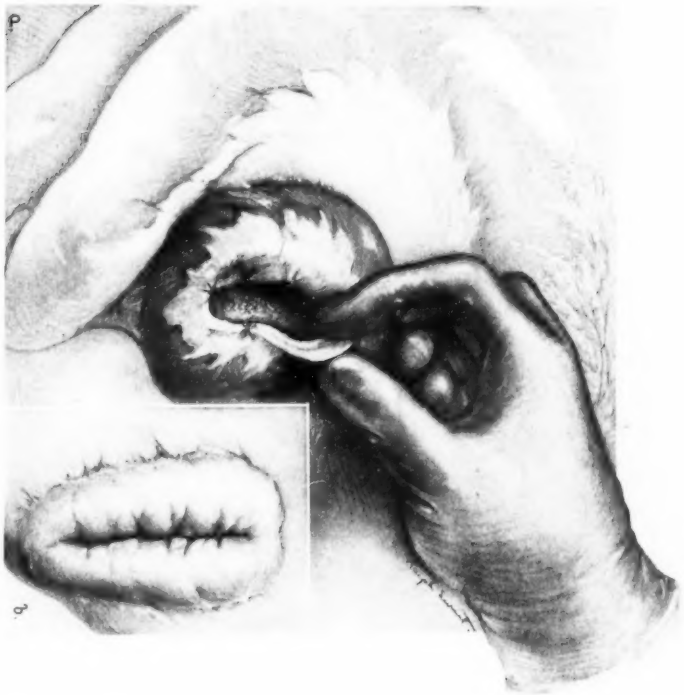

Fig. 5. A, Placing of interrupted sutures in repair of tuberculous abscess cavity. B, Final closure with interrupted chromic catgut.

by otitis media. One month ago, she had had an attack of pain with vomiting. On the day of admission to the hospital the child was awakened by pain in the region of the navel; the pain was gradual in onset, severe and colicky with nausea, vomiting, and tenderness to pressure over the abdomen.

Some tenderness and spasticity were present on the right side of the abdomen; the temperature was 99.6 degrees F. Urinalysis was negative except for a few red blood cells and a trace of albumin. White blood count, 14,000; polymorphonuclears, 89 per cent; small lymphocytes, 9 per cent; large mononuclears, 2 per cent.

Operation. September 20, 1926. Chronic appendicitis and many mesenteric glands were found, the glands varying in size from shot to almonds, the larger number being in the cæcal area. Some glands, to the sense of touch, seemed irregular and calcified. The pathologist reported old healed tuberculosis of the gland excised, and chronic appendicitis.

The patient was dismissed on October 3, 1926, and on December 3, 1926, was reported in good condition. In February, 1927, the parents reported slight attacks of abdominal pain. The child is gaining in weight and strength and her progress is satisfactory.

CASE 5. H. R., male, age 2, entered the hospital October 14, 1925. The past history was negative.

On October 14, 1925, without evidence of previous nausea or pain, the child suddenly vomited just before dinner. He had no fever. He vomited again at midnight and often through the rest of the night. There was no distress between attacks of vomiting.

The child looked ill, but there were no other positive physical findings. The urinalysis was negative. White blood count, 10,060; polymorphonuclears, 83 per cent; small lymphocytes, 14 per cent; large mononuclears, 3 per cent.

Operation. October 17, 1925 showed intussusception at the junction of the jejunum and ileum, with very marked mesenteric lymphadenopathy. The pathologist returned a report of an inflammatory gland. This child had a stormy convalescence but was discharged in good condition on November 6, 1925. He was seen on January 8, 1926, and appeared entirely normal.

At the time of writing, his condition is entirely satisfactory.

This group, consisting of 6 cases of which only 2 are reported, illustrates the very acute onset of the disease with the general picture, one of severe illness. One case which was not operated upon showed tuberculous meningitis as well as tuberculous mesenteric lymphadenitis, at post mortem examination. Intussusception has been noted as a complication by numerous authors.

REPORTS OF CHRONIC CASES WITH ACUTE EXACERBATIONS

CASE 8. P. W. D., a male, age 9, entered the hospital on August 9, 1925, complaining of pain in the right lower abdomen, and vomiting. The patient had had two previous attacks of pain in the right lower quadrant of the abdomen, with fever and vomiting. The present illness began with continuous pain on August 6, 1925. The temperature was 103.6 degrees F., pulse rate 120; the tonsils were large and red; tenderness, over the entire abdomen, was especially marked in the right lower quadrant and in the left lower quadrant; moderate rigidity was noted with no masses. The spleen was palpable beneath the costal margin. The white blood count was 8,100 polymorphonuclears, 81.5 per cent; small lymphocytes, 17.5 per cent; large mononuclears, 1 per cent.

Operation. Chronic appendicitis; many large clusters of inflammatory retroperitoneal glands, glands of the mesentery and small bowel. The pathologist reported subacute mesenteric lymph nodes without suggestion of tuberculosis.

X-ray treatment was given on August 21, 1925, and the patient was dismissed the following day, still with some rise in temperature. On August 24 another X-ray treatment was given. The patient, gained about 10 or 15 pounds and was entirely well until about October 8, 1926. He re-entered the hospital on October 18, 1926 with the complaint of cramps, vomiting, and fever of 10 days' duration. At the time of entry the physical examination was negative except for abdominal tenderness and distention, temperature, 104; white blood count, 12,400; polymorphonuclears, 78 per cent; small lymphocytes, 10 per cent; large mononuclears, 1 per cent; transitionals, 11 per cent. X-ray therapy was given and the patient was dismissed on October 13, 1926, with a normal temperature. Another X-ray treatment was given on November 6, 1926. On January 6, 1927, the boy's mother reported that he still had attacks of pain in the stomach and head for 3 or 4 days every 2 or 3 weeks but that the attacks were not severe. At the time of writing his condition is very satisfactory.

CASE 14. W. S., male, age 31, entered the hospital on April 19, 1926, complaining of indigestion and nervousness, and pain in the left upper quadrant, colicky at times.

The patient had had recurring attacks of abdominal pain since childhood; he had been pale and sickly in childhood. He had had influenza in 1922, but not a severe attack. Constipation had been severe and continuous since 1920, with gas and sour stomach a half hour after meals. The symptoms could be occasionally relieved for two or three days, and would then return. Pain was noted under and over the heart, and "indigestion" without nausea or vomiting. In April, 1925, he had an attack of sharp colicky pain which lasted about one week and was cured by diet. No other attacks of acute pain were reported. The physical examination was negative. The X-ray showed a possible gastric ulcer. White blood count, 9,000; polymorphonuclears, 70 per cent; small lymphocytes, 23 per cent; large mononuclears, 7 per cent. The urinalysis was negative. The patient was given an ulcer diet which relieved his symptoms (patient neurasthenic) and he was discharged from the hospital on May 1, 1926. He was put on a regular routine and gained weight and strength. On January 17, 1927, he re-entered the hospital complaining of great abdominal pain. He had fallen 15 feet. The abdomen was distended and tympanitic and there was much blood in the urine.

Operation. At the root of the mesentery was found a ruptured tuberculous cyst wall the size of a baseball. A portion of the cyst was removed for diagnosis and the pathologist reported inflammatory hyalin and fibrous tissue without evidence of epithelial tissue. A culture of pus from the cyst was negative. There was a generalized enlargement, apparently tuberculous, of the mesenteric glands, some one inch in diameter. The largest were in the root of the mesentery. No glands were caseous. About one pint of flaky caseous material was removed by aspiration from the abdomen. Ileostomy and aspiration of the small intestine were done because of paralytic ileus and obstruction of the small bowel (Figs. 4 and 5).

In this group of 8 cases the extreme chronicity of the condition is shown. The usual syndrome is vague intermittent attacks of abdominal pain over long periods of time. Because of the continued pain the condition is demonstrated by an exploratory laparotomy.

The complications in this group were obstruction of the duodenum by a mass of glands at the ligament of Treitz in one instance and "giant cell hyperplasia" or "pseudo-Hodgkin's disease" reported by the pathologist in another instance. In the latter case, the patient is now entirely well.

There is probably no other type of disease so widely disseminated in the animal kingdom as tuberculosis. Man is continuously exposed

to infection from contact with his fellow men suffering from the disease and from the infected food which he ingests. That he often succumbs to it is proved by our death rate from tuberculosis. That he overcomes the infection or holds it stationary is shown by post mortem examinations.

When dealing with such a very widely disseminated disease, we must ever keep it in mind.

The clinical picture of enlarged cervical, bronchial, or mesenteric glands should suggest it.

SUMMARY

1. All cases of mesenteric lymphadenitis should be treated as tuberculous until proved otherwise.

2. All cases of suspected mesenteric lymphadenitis, either acute or chronic, should have an exploratory laparotomy because of the various pathological complications which may exist and the extreme danger of failure to diagnose acute appendicitis.

3. Heliotherapy should be given for those patients who do not promptly respond to sunlight, rest, and a high caloric diet.

4. X-ray therapy is of great value in the acute form and in the chronic form with acute exacerbations where there is marked glandular enlargement without caseation. Because of the cost of X-ray treatment, it is not suggested as a routine.

5. Operative removal of glands should not be undertaken except for pathological examination, unless the glands are caseous or are abscessed.

6. The examination of the mesentery for enlarged glands should be a routine whenever an abdomen is opened.

7. Tuberculous mesenteric glands are common in various stages of disease without symptoms. Activation is caused by environmental and hygienic conditions, physical exercise, or intercurrent superimposed infections which lower resistance to the invasion of tubercle bacilli.

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CHOLECYSTOGASTROSTOMY FOR GASTRIC ULCER[1]

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IN the recent surgical literature much attention has been given to the problem of the treatment of round gastric ulcer, but the final word has not yet been said. Several methods of surgical treatment have gained general recognition. Some of them such as gastro-enterostomy have been proved valuable by abundant clinical material; while others, neither less scientifically correct nor less expedient, perhaps, must be given further trial before they can be generally accepted. We have in mind cholecystogastrostomy which as an operation for gastric ulcer is excellent in theory but has not been extensively tested clinically and experimentally.

In Russia, in 1923, Professor Bogoraz[2] was the first to advocate cholecystogastrostomy as a means of controlling one of the principal conditions for the development of gastric ulcer, namely, hyperacidity of the gastric contents. His idea, to attain prolonged neutralization of acid contents by a continuous flow of bile into the end of the stomach, was justified by the excellent postoperative results achieved by him in his 25 cases.

We have reasons to believe that neutralization of the acid contents would be more apt to occur after cholecystogastrostomy than after gastro-enterostomy; because cholecystogastrostomy augments the tendency of the body to neutralize high acidity by throwing an alkaline mixture, chiefly bile, from the intestine into the stomach. This fact has been established in the writings of some of the surgeons belonging to Porlov's school (Boldirev). Long ago, Dastre, Oddi, Cannac, and Masse, in animal experiments, arrived at the conclusion that bile, sidetracked to the stomach, produces no noticeable digestive disturbances.

In 1892 Wickhoff and Angelberger performed a cholecystogastrostomy on a man with a tumorous obstruction of the bile duct. In the literature up to 1918, over 100 cases of cholecystogastrostomy for obstruction to the bile duct were reported. In most of these cases, the obstruction was a malignant growth. But at present, cholecystogastrostomy is advocated as a method of treatment for round gastric ulcer.

We have performed this operation in 32 cases of gastric ulcer. The end-results were satisfactory and were reported at the seventeenth congress of Russian Surgeons at Moscow, May, 1926. After the operation the patients were free from symptoms and were able to resume their occupations. The gastric juice was analyzed at various periods during the course of 1½ years and a decrease in acidity and the constant presence of bile (macroscopic) found.

We do not intend to give here a detailed account of all our material, as it was included in the published report of the Congress.[3] The purpose of the present paper is to report the observations made at the secondary laparotomies done upon 4 patients who had previously undergone cholecystogastrostomy for gastric ulcer. We give here short extracts from the clinical histories of the 4 cases.

Case 1. T. V., male, aged 22, admitted to the clinic on May 13, 1925, suffered great pain in the region of the stomach. He had been disabled for 2 months. Clinical examination revealed gastric ulcer. Repeated investigations showed high acidity of the gastric contents. At operation a large indurated ulcer was found on the lesser curvature. A cholecystogastrostomy was done. Examination made at the clinic 3 months after operation showed no pain and a decrease in acidity. But after 6 months, pain of the old character recurred, and hyperacidity was present again. A second operation was done, and the abdominal cavity opened. The anastomosis between the gall bladder and the stomach, measuring 1 centimeter, that had been sutured in during the first operation was found constricted. A new anastomosis, measuring 2 to 3 centimeters, was made. The infiltration at the site of the ulcer was found considerably diminished. The patient was discharged as cured. After 6 months he came back complaining of the former pain in the region of the stomach. A secondary

[2] Bogoraz, N. Arch. f. klin. Chir., 1925, cxxxvii, 1.

[3] Nazarov, N. Arch. f. klin. Chir., 1926, cxli, 3.

[1] Dedicated to the forty-fifth Jubilee of Professor V. Razumovsky.

laparotomy was done, and the anastomosis, examined through the incision in the stomach, was found so constricted that the point of closed Kocher forceps could hardly be inserted. The opening was therefore dilated with bougies until the index finger could be inserted. No infiltration would be palpated at the site of the ulcer. The acidity was lessened. Recovery resulted, and for the last 6 months the patient has been enjoying good health.

CASE 2. T. J., male, aged 37, was admitted to the hospital with severe pain in the region of the stomach and high acidity of the gastric contents. The condition was diagnosed as gastric ulcer. At operation, under novocain, a large, indurated ulcer was revealed on the lesser curvature. A cholecystogastrostomy was performed and the anastomosis, measuring 2 centimeters, was sutured in. Within the first months following the operation pain disappeared and the acidity diminished. After 5 months, pain returned with its former acuteness and infiltration of the ulcer was not lessened. The tip of a sound could scarcely be passed through the anastomosis. A gastro-enterostomy was performed and the pain disappeared. The patient recovered and ganied 16 kilos in weight within 2 months after the operation.

CASE 3. T. V., male, aged 52, on admission, suffered from gastric ulcer with hyperacidity of the gastric juice. The operation revealed an indurated ulcer on the lesser curvature. After cholecystgastrostomy the patient was discharged as cured. After 9 months he returned, the pain being as great as before. Acidity of the gastric juice was again increased. He was subjected to a secondary laparotomy, and a carcinoma was found occupying the site of the former ulcer and extending over the entire area of the anastomosis. Resection could not be undertaken for several reasons. The patient left the hospital in a somewhat better condition

CASE 4. M. K., male, aged 24, was admitted with gastric ulcer and high acidity of the gastric contents. The operation revealed a small, soft ulcer on the lesser curvature with infiltration 1 centimeter in diameter. Recovery followed cholecystogastrostomy. Pain totally disappeared and the acidity of the gastric contents diminished. After 5 months the patient returned to the clinic with an acute form of appendicitis. The appendix was removed through an incision starting at the costal margin and running parallel to the external margin of the rectus muscle. The anastomosis between the gall bladder and the stomach admitted the passage of a bougie and no adhesions were present. The former ulcer was impalpable and no infiltration could be noted at its former site. The patient recovered and was discharged as cured.

From the referred data, definite conclusions as to the value or shortcomings of the method cannot be drawn. However, these cases, with repeated operations, afford a basis for valid practical inference. It is obvious that the anastomosis at cholecystogastrostomy has to be of sufficient length—not less than 2 to 3 centimeters—otherwise in a short while we may expect to find constriction, increased acidity of the gastric contents, and the recurrence of symptoms of ulcer.

In Cases 1 and 4, when we investigated the gall bladder with a finger inserted through the anastomosis, we found no trace of food remnants. The danger of food getting into the gall bladder cannot be considered serious. We may admit that the anastomosis assumes the function of a sphincter, the sucking action of the stomach forcing the bile into the stomach when it is needed. The abundance of bile found during digestion in the stomachs of the patients operated upon would seem to indicate that this could occur. However, it is hardly probable that food could easily pass into the gall bladder.

In Cases 1 and 4 we found that infiltration at the site of the ulcer disappeared after cholecystogastrostomy. The inflammatory induration at the site of the ulcer had absolutely disappeared within 6 months after the operation. This was probably due to the decrease in the acidity of the gastric contents brought about by the admittance of bile.

Cholecystogastrostomy should not be undertaken in cases of large, indurated ulcers (Cases 2 and 3), as there is a possibility of cancerous degeneration. In Case 2 the indurated ulcer remained in the same condition 5 months after the operation. In Case 3 we found after 9 months an unmistakable carcinoma at the site of the former ulcer. In these cases resection of the stomach is the operation of choice.

We are coming to the conclusion that cholecystogastrostomy is contra-indicated in cases of ulcer with only a little soft infiltration; that is, in the cases in which, up to the present time, the majority of surgeons considered gastro-enterostomy the operation of choice. In these cases cholecystogastrostomy has many advantages over gastro-enterostomy.

1. Cholecystogastrostomy is a technically simpler operation.

2. It does not involve any of the serious complications resulting from gastro-enterostomy in certain cases.

3. It is more nearly physiologically correct and more logical.

We have to add that the method advocated by us is new and has not been proved successful in a large number of cases; but the results obtained in the cases which we were able to follow for a year and a half seem to us highly satisfactory. We therefore believe that cholecystogastrostomy may become the operation of choice in certain cases of gastric ulcer.

ORTHOPEDIC RECONSTRUCTION WORK ON HAND AND FOREARM

Report on Early and Late Results[1]

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IN reconstruction work on chronic disabilities of the upper extremity, the plan obviously must be based on the physiological and mechanical principles of normal function. This does not mean that the essential pathological conditions can be ignored. But in most cases the disability represents a remote deforming process, which has terminated in a definite stage of biological cure in which all tissues have come to a state of rest. Therefore we find that all plans of reconstruction have been shaped according to the musculomechanical factors involved and the operative indications determined by physiological laws. The principal aims of reconstruction of hand and forearm, mechanically and dynamically formulated, are as follows:

Active supination of the forearm must be made possible in order that the hand be able to turn an object.

The wrist must be provided with a sufficient degree of stability in a suitable position of hyperextension; this forms the mechanical basis for the function of the fingers.

Finger flexion for the grip and extension for release are of almost equal importance, as efficiency records show, and an active equilibrium between both actions is an important prerequisite.

The same is true of thumb function, the degree of opposition and adduction necessarily being determined by the ability to extend or adduct.

These cardinal postulates for hand and forearm again invoke definite dynamic requirements for elbow and shoulder inherently necessary for the function of the hand. By analyzing the intricate functions of the extremity into its principal components, and by recognizing their share of importance for functions, operations can be devised and performed which will correct certain definite points, and the operative material can be clarified accordingly.

The operative side of reconstruction work, however, is only a part of the whole scheme and not always the most important one. The greater burden always rests upon the postoperative re-education.

The report here submitted supplements others made upon the reconstruction of the whole extremity 3 years ago. It is, however, confined to the hand and forearm alone and embraces 250 patients with a total of 450 operations. The opportunities of longer postoperative observation and of additional experiences allow of more definite conclusions in certain conditions; other problems still appear unsolved.

Of the larger number of disabilities which constitute this series, 8 types have been chosen for this report. According to whether the correction of the alinement or restitution of motion form the principal object of a particular operative procedure, the series is again subdivided into 4 types representing principally restoration of form and 4 rep-

[1]Read before the Clinical Congress of the American College of Surgeons, Montreal, Canada, October 26, 1926.

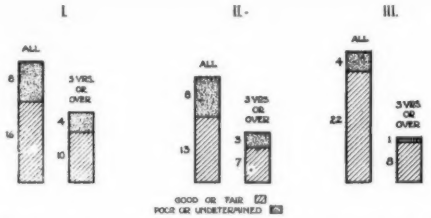

Chart 1. Restoration of form. Group A, wrist flexion contracture. *i*, Arthrodeses for spastic wrists, 24 cases; *ii*, tenotomy and tenoplastic operations for spastic wrists, 21 cases; *iii*, tenotomies and tenoplastic operations for ischæmic and congenital contractures, 26 cases; total 71 cases.

resenting restoration of function. Our object is not so much the presentation of the merits of a single operation as that of combinations of operations.

RESTORATION OF FORM

Group A. Flexion contracture of the wrist. The first mechanical postulate for the function of the fingers is to place the wrist in hyperextension. The desired result is secured by one of three methods depending upon the type of case.

1. Correction by arthrodesis of the wrist was used in 24 cases of spastic paralysis. The early results were good in 16 cases, poor in 8; the late results were good in 10 cases, poor in 4 (Chart 1, i). Arthrodesis was combined with operations for restoration of function in the majority of cases in this group: with tenoplasty on the muscles of the forearm in 4 cases, with tenoplasty on the flexor muscles of the elbow in 2 cases, with thumb checks in 3, with tendon transplants in 4, and with pronator resections in 3.

Arthrodesis was chosen as the means to procure position, because control of the position by muscle action was difficult and unreliable; tendon transplantation, on the other hand, was used in suitable cases of this type to procure extension of the fingers.

2. Correction by tenotomy and tenoplasty of wrist flexors was used in 21 cases of spasticity. This operation was combined with arthrodesis of the wrist in 2 cases, with thumb checks in 2 cases, with tendon transplantations in 2 cases, and with pronator resections in 3 cases.

Chart 2. Restoration of form. Group B, pronation and supination contractures of wrist. *i*, Forearm pronation, pronator resection, 18 cases; *ii*, forearm supination, supinator resection, 3 cases; *iii*, whole arm pronation, Sever's operation, 13 cases; total 34 cases. Combinations: tendon plastic operations, 5 cases; thumb check operations, 3 cases; arthrodesis of wrist, 3 cases; tendon transplantation operations, 4 cases.

Arthrodesis of the wrist was not added to the operations on soft structures when moderate flexion contracture was present or when only a few muscles, especially the flexor carpi ulnaris, were contracted. In these cases equilibrium of the wrist was likely to be restored without arthrodesis. The immediate results were good in 13 cases, poor in 8; the late results good in 7 cases, poor in 3 (Chart 1, ii).

3. Non-paralytic wrist flexion contractures (Volkmann's contractures, congenital, arthritic, and traumatic contractures) were corrected by tenotomy and tenoplasty in 26 cases. The operation was combined with arthrodesis of the wrist in 4 cases, pronator resection in 2 cases, tendon transplantation in 2 cases, tendon graft in 1 case, and with a plastic operation on the thumb in 3 cases. The immediate results were good in 22 cases, poor in 4; the late results good in 8 cases, poor in 1 (Chart 1, iii).

Group B. Pronation and supination contractures of the wrist. There were 34 cases in this group.

1. Correction by pronator resection was used in 18 cases, the conditions treated being spastic paralysis and ischæmic contracture. The early results were good in 11 cases, poor in 7; the late results good in 6 cases, poor in 3 (Chart 2, i).

2. Correction of supinator contracture by section of the supinator brevis and biceps was done in 3 cases of spasticity. The result was good in 2 cases, poor in 1 (Chart 2, ii).

3. Whole arm pronation was corrected by Sever's operation, tenotomy of the subscapularis, coracobrachialis, and pectoralis tendons

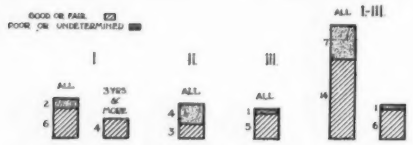

Chart 3. Restoration of form. Group C, contracture of fingers, tendinous, arthritic, neuritic, traumatic. *i*, Metacarpal osteotomies and resections; *ii*, plastic operation on flexor extensors; *iii*, finger plastic operations and capsulotomies. The cases may be divided into ischæmic 10, spastic 2, arthritic 4, neuritic 2. The total number of cases in this group was 21.

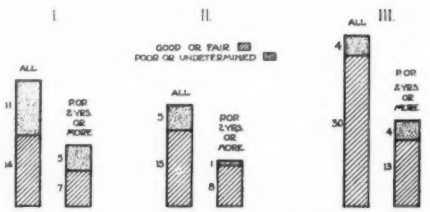

Chart 4. Restoration of form. Group D, dermatogenetic contractures. *i*, Local flaps, 25 cases; syndactylism, 14 cases; congenital contractures, 3 cases; scar contractures, 6 cases. *ii*, Shift flaps, Pieri, 20; syndactylism, 4 cases; traumatic contractures, 4 cases; burns, 9 cases; congenital contractures, 3 cases. *iii*, Italian flap, 34 cases; burns, 25 cases; traumatic, 3 cases; syndactylism, 4 cases; others, 2 cases. The total number of cases in this group was 79.

in 13 cases, the conditions treated being obstetrical palsy and spastic paralysis. The early results were good in 12 cases, poor in 1; the late results good in 4 cases, poor in 1 (Chart 2, iii).

This operation, although carried out at the shoulder, is included in the series because of its effect upon supination of the forearm and hand. The operation was combined with tenoplasty in 5 cases, with thumb check in 3, with arthrodesis of the wrist in 3, and with tendon transplantation in 4.

Group C. Contracture of the fingers. There were 21 cases in this group, including cases of tendinous, arthritic, neuritic, and traumatic contracture. Not included in this group are those cases of finger contractures released by plastic operations on the flexor tendons of the wrist (Chart 1). In the group were 10 cases of ischæmic contracture, 2 of spastic contracture, 5 of arthritic, and 3 of neuritic.

1. Metacarpal osteotomy and resection was done in 8 cases of advanced claw-hand deformity. The immediate results were good in 6 cases, poor in 2, the late results good in 4 cases, poor in none (Chart 3, i).

Metacarpal osteotomy is especially useful in advanced arthritic claw-hand with dislocation of the basal phalanx upon its metacarpal bone.

2. Plastic operations were performed on the finger flexors and extensors of the hand or fingers, in 7 cases. The results were good in 3 cases, poor in 4 (Chart 3, ii).

3. Capsulotomy of the posterior capsule of the metacarpophalangeal joints was added to tenoplasty of the extensor in 6 cases of arthritic claw-hand. The results were good in 5 cases, poor in 1 (Chart 3, iii).

Group D. Dermatogenetic contractures; skin surgery. There were 79 cases in this group, most of the cases being of syndactylism, burn and congenital contractures.

1. Local skin flaps were used in 25 cases. The methods of Didot, Tubby, and others were followed. There were 14 cases of syndactylism, 3 of congenital contracture, and 6 of scar contractures. The results in this group were only fair, the immediate result being good in 14 cases, poor in 11; the late results good in 7 cases, poor in 5 (Chart 4, i).

2. Shift flaps after the method of Pieri were used in 20 cases, 4 cases being of syndactylism, 4 of traumatic contracture, 9 of burns, and 3 of congenital contracture. The results of this type of operation were much better than those of the former. There was less interference with primary wound healing and less tendency to recurrence. The immediate results were good in 15 cases, poor in 5; the late results good in 8 cases, poor in 1 (Chart 4, ii).

3. The Italian flap method was used in 34 cases: burns, 25; traumatic contractures, 3; syndactylism, 4; and other cases, 2.

The development of the Italian pedunculated flap method constitutes one of the most gratifying chapters in the reconstruction work of the hand and fingers. We found its results fairly stable if prolonged after-treatment and splinting followed the operation.

The immediate results were good in 30 cases, poor in 4; the late results good in 13 cases, poor in 4 (Chart 4, iii).

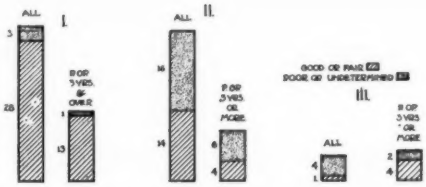

Chart 5. Restoration of function. Group A, drop wrist and fingers. *i*, Stabilization: arthrodesis, infantile paralysis, obstetrical paralysis, ischæmic paralysis, congenital club hand, etc. *ii*, Mobilization: tendon transplantation—flexors to extensors for infantile paralysis, 7 cases; spastic paralysis, 16 cases; others, 7 cases. Group B. *iii*, Loss of supination. Tubby's transposition of pronator radii teres. Transposition of flexor carpi ulnaris. Combinations: tendon transplantation, 9 cases; thumb plasties, 5 cases; elbow flexor plastic operations, 9 cases, etc. Combinations: arthrodesis—wrist, 11 cases, tendon plastic operations, 4 cases, etc.

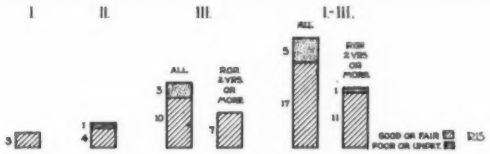

Chart 6. Restoration of function. Group C, tendon reconstruction: traumatic, ischæmic, inflammatory contractures. *i*, Sutures, 3 cases; *ii*, tendon grafts, 5 cases; *iii*, tendon plastic operations, 14 cases, total 22 cases.

RESTORATION OF FUNCTION

Group A. Drop wrist and drop fingers.

1. Stability was restored by arthrodesis in 31 cases of infantile paralysis, obstetrical paralysis, ischæmic paralysis, congenital club-hand, etc. Here are classified procedures which have for their primary object either stability or mobility of joints, or both; the restoration of form being a prerequisite. Combined operations were tendon transplantation in 9 cases, plastic operations on the thumb in 5 cases, and tenoplasty of the elbow flexor in 9 cases. The functional results in this group were favorable, though they represent the effect of combinations and not of a single operation. The immediate results were good in 28 cases, poor in 3; the late results good in 13 cases, poor in 1 (Chart 5).

2. Mobilization by tendon transplantation. The flexors of the wrist were transplanted to the extensors of the fingers in 30 cases. The conditions were infantile paralysis, 7 cases; spastic paralysis, 16 cases; other conditions, 7 cases. The operation was combined with arthrodesis of the wrist in 11 cases, tenoplasty in 4, etc. The immediate results were good in 14 cases, poor in 16; the late results good in 4 cases, poor in 6 (Chart 5).

In general the late results of tendon transplantation were not as good as expected. Causes of failure were errors in indications as well as errors in technique, the latter probably prevailing. There are a number of technical difficulties: the necessity of leading the tendon through several fascial compartments facilitates the formation of adhesions. The tendon must be immobilized for a long distance in order to obtain a straight line of pull. The tendon sheath must be preserved or reconstructed and the suture must be mechanically accurate.

Group B. Tendon transplantation for loss of active supination.

1. Tubby's method of transposing the pronator radii teres was used in 4 cases of spasticity. The initial results were better than the late results (Chart 5). Mechanical inefficiency of the transposed muscle (pronator teres and flexor carpi radialis) seemed to be the principal cause of failure.

2. Transplantation of the flexor carpi ulnaris was done in 4 cases of spasticity. The flexor carpi ulnaris is led from the internal epicondyle obliquely over the dorsal surface of the forearm to the lower end of the radius. The method is still on trial but the immediate results are promising (Chart 5, iii).

Group C. Impairment of finger flexion. There were 15 cases in this group, including cases of traumatic, ischæmic, and inflammatory disabilities of the flexor tendons.

1. Simple suture of tendons. Although the group is small the result of simple sutures or plastic procedures was fairly satisfactory. Failures were due to postoperative adhesions or deficiencies in the after-treatment. On the whole the results were good mechanically and anatomically. Functionally they depended largely upon the underlying pathological condition (Chart 6, i).

2. Implantation of tendons was used in 6 cases of inflammatory and ischæmic con-

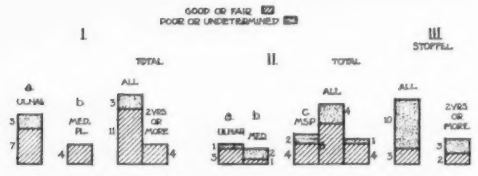

Chart 7. Restoration of function. Group D, Peripheral nerve surgery. *i*, Neurolysis: *a*, ulnar, for delayed ulnar palsy, 6 cases; traumatic paralysis, 4 cases. *b*, median and plexus for ischæmic, 1 case, and traumatic, 3 cases. *ii*, Suture: of ulnar, median and musculospiral for ischæmic paralysis, 1 case; traumatic paralysis, 9 cases, and others, 2 cases. *iii*, Stoeffel operation—median and ulnar, 13 cases. The total number in this group was 35 cases.

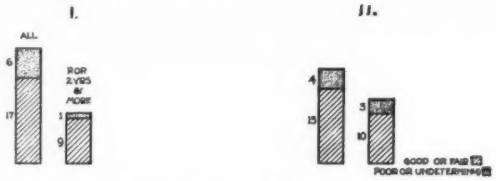

Chart 8. Restoration of function. Group D or E. Thumb action deficiencies. *i*, Inability to oppose and adduct: infantile paralysis, ischæmic paralysis, traumatic paralysis, burn contractures. *ii*, Inability to extend and abduct, spastic paralysis. The total number of cases in this group was 42. Thumb flexor plastic operation was done in 23 cases. In this group combination operations were done as follows: tendon plastic operation on the forearm, 4 cases; flexor plastic operation at elbow, 4 cases; pronator resection, 1 case. Of the thumb check operations, 19 cases, combination operations were done as follows: tendon plastic operation on forearm, 4 cases; flexor plastic operation on elbow, 4 cases, pronator resection, 3 cases; tendon transplantation, 2 cases.

tracture with extensive scar formation. In 5 instances the peroneus longus was used for the implant and in one the palmaris longus. (Chart 6, ii).

It was the policy in cases of traumatic and inflammatory destruction of the flexor tendons of the fingers to carry out a painstaking resection of all scar tissue. A soft tissue bed was thereby obtained into which the implant was laid together with its natural gliding apparatus. The dissection was made well into the healthy tissue above and below the scarred region so that the suture would be laid in comparatively healthy surroundings. The results on the whole were satisfactory and remained so or improved with longer observation, being good in 5 cases, poor in 1.

Group D. Peripheral nerve surgery. This group was composed of cases treated by neurolysis, nerve suture, and Stoeffel's operation.

1. Neurolysis (ulnar, median and plexus) was used in 14 cases, including 6 cases of late ulnar palsy, 7 of traumatic paralysis, 1 of ischæmic paralysis. The results of ulnar neurolysis, including the 6 cases of delayed ulnar palsy were good (7 good, 3 poor). Those of neurolysis of the median nerve and plexus also gave good results (4:1), with full return of function.

The total showed a ratio of 11:3; late results 4:0 (Chart 6, i).

2. Nerve suture was employed in 13 cases, including 4 cases of ulnar nerve suture; 3 of median nerve; and 6 of musculospiral nerve suture; 1 case of ischæmic paralysis; 9 cases of traumatic paralysis; and 2 cases of other conditions (Chart 7, ii). Results of ulnar nerve suture were fair (3:1). Those of the median nerve suture were poor (1:2). The best results obtained were those of musculospiral nerve suture (4:2).

3. Stoeffel's operation (selective resection of the median and ulnar nerves in spastic paralysis) was done in 13 cases (Chart 7, iii). In general, the results of Stoeffel's operation on the forearm were poor, the ratio of good to poor being, immediate, 3:10; late, 2:3. The reason for this lies largely in the difficulty of estimating the amount of nerve motor supply to be removed and in the difficulties of re-education. The extensors are often extremely weak so that active muscle equilibrium is hard to obtain.

Group E. Thenar disability, with lack of opposition and extension of the thumb.

1. Flexor plasty for lack of opposition of thumb was done in 23 cases, including cases of infantile paralysis with thenar palsy, ischæmic contractures, peripheral paralysis.

To overcome this very great disability the long flexor of the thumb is split and the outer half is laid around the outer and posterior contour of the base of the first phalanx of the thumb. Acting as a guy rope together with the long flexor the contraction of the latter swings the thumb in opposition to the fingers. The operation proved highly dependable, the results being, immediate, 17 good, 6 poor; late, 9 good, 1 poor (Chart 8, i).

2. The thumb check operation for inability of extension and abduction of the thumb was done in 19 cases of spastic paralysis, the immediate results being 15 good, 4 poor; the late, 10 good, 3 poor.

This method introduced by Mayer and Biesalski proved very useful in cases of spasticity in which extension and abduction of the thumb was too weak to prevent the latter from being caught under the fingers when the fist was closed. The operation is simply an anchorage of the extensor proprius of the index finger to the long extensor of the thumb to act as a check against flexion. Of the 19 cases operated upon 15 were successful and 4 were failures (Chart 8, ii).

AFTER-TREATMENT

A few words should be said about the after-treatment because it constitutes a most important phase of the treatment and determines more than any other factor the ultimate outcome. The principle of the immediate after-treatment was that of immobilizing the hand in the position of correction, or in cases of tendon transplantation or tenoplasty in the position of relaxation of the transplanted tendon. Active motion was started in cases of tendon transplantation after the seventh day and of tenoplasty or implant after the tenth day, appropriate splints being worn from the moment of removal of the primary cast.

When operations were combined, concessions had to be made to the one requiring the longer period of fixation, for instance, in cases of combination of arthrodesis with tendon transplantation. This necessitated, sometimes, considerable departure from the routine of the individual operation but we have noticed no evil effect of such necessary delay in instituting active or passive motion.

MUSCLE TRAINING

Muscle drill and muscle training represent a higher degree of functional development. In our cases they had their due place in the more advanced stages of recovery. For this work a definite system was devised based upon the development of exact hand and finger movements with the use of standardized objects, as well as upon the development of speed and precision.

In general, the earlier experiences on the merits of the operative methods have been corroborated by late observations. In some fields, such as tendon transplantation, selective nerve resection, etc., the final results fell behind expectations. We feel that the results are encouraging enough to accord to orthopedic surgery of the hand and arm a much wider application than it now enjoys.

THE ORTHOPEDIC ASPECT OF LOW BACK PAIN IN CONNECTION WITH PELVIC DISORDERS[1]

By PHILIP H. KREUSCHER, M.D., F.A.C.S., Chicago

PAIN in the back is one of the most prevalent conditions encountered by the physician. It is as loosely diagnosed as rheumatism and equally badly managed. All too frequently the belladonna plaster or a prescription for aspirin or cinchophen is substituted for a painstaking examination. Even after the most careful examination we are occasionally at a loss as to the etiology. For some years I have endeavored to carry in my mind a little outline which I have found of great assistance. I think of backache as having its origin (1) in some abnormal condition in a distant organ in the thoracic, abdominal, or pelvic cavities; (2) in some organ or in the tissue lying contiguous to the spine; (3) in a disturbance of nerve trunks or plexus; (4) in diseases or disturbances in the spine itself or in the sacro-iliac synchondrosis.

A number of years ago a patient came for examination complaining of severe low back pains. She stated that for several years she had had pain in her back especially upon standing, walking, lifting or repeated stooping. She had consulted many physicians but had never obtained permanent relief. She stated that she had been just examined by Dr. X. who had told her that she had a severe tipping of the uterus, that the uterus lay against her backbone, and that the ovaries and tubes were behind the uterus also severely pressing against the back. He told her furthermore that in order to get complete relief she must have an operation, that he would shorten the round ligaments and that this would straighten everything.

My object in presenting this paper is to show that very little relation exists between pelvic infections and low back pains except in rare cases in which some of the sacral plexus of nerves are involved by more or less extensive generalized pelvic infection. Furthermore, I wish to show that there is little reason for the popular opinion among the laity and also with some men in the practice that malpositions of pelvic organs give rise to much backache. The points I wish to make are: (1) that only in comparatively few instances can low lumbar or sacro-iliac pain be attributed to pelvic disorders *per se;* (2) that the nerve supply of the uterus and adnexa has a much higher origin than we generally believe; (3) that upon careful examination a more rational cause can be found in most backache cases; (4) that the care of back pain cases in women as well as in men belongs in the realm of the orthopedic surgeon.

We must differentiate definitely between actual pain and local sensitiveness or tenderness. You as gynecologists know that many cases show marked pelvic tenderness upon a vaginal examination who do not have actual pain in the back. Furthermore, that the retroversion or retroflexion of the uterus, even in the third degree, does not bring the organ and its adnexa into direct contact with the spine nor do definite pressure symptoms usually exist.

A study of the nerve supply of the uterus brings to our attention the fact that the innervation for the most part comes from the pelvic plexus (sometimes called the inferior hypogastric), the ovarian plexus, and a few filaments from the sacral nerves. This pelvic plexus has its origin in the hypogastric which in turn originates from the aortic plexus and upper lumbar ganglion.

The ovarian plexus is derived from the renal plexus, receiving some filaments from the aortic plexus. It will be remembered that the renal plexus comes from filaments of the solar plexus and the outer part of the semilunar ganglion. We see then that there is no logical reason for the transmission of pelvic pain into the lower lumbar or sacro-iliac region.

Careful examination will show that there are other more plausible causes in the production of this common complaint. No one will deny that backache is more prevalent in women than in men. The spine and pelvis of

[1] Read before the Chicago Gynecological Society, December 17, 1927. (For discussion see p. 567.)

the male are built for the performance of heavy duty, standing, walking, and lifting. The ligamentous structures are more massive, being more fully developed by exercise and labor. The relation of the female pelvis to the sacrum and spine is entirely different; the size and shape of the pelvis is different. The posture line in the male is erect. The spine comes directly upon the sacrum designed to give strength and endurance. Compare that with the posture line of the female, that of gentle curves in the upper spine and the forward, almost lordosis curve in the lumbar spine drawn by artists along lines to represent grace and flexibility. Fashion and habit have been definite factors in producing anatomical lines, although the more graceful are prone to excessive curves and consequently deformity which in many instances means pain. There was that period in which tight fitting apparel produced a narrow waist line and a consequent displacement of most of the abdominal viscera into the lower abdomen and pelvis. Then came the period when it was fashionable to droop the shoulders and to counteract that a protrusion of the abdomen, which eventually may result in a pendulous abdomen, thus causing a lordosis deformity and an abnormal forward tilting of the pelvis. This posture brings about definite deformity and with it the ultimate cause for backache. The child-bearing function brings with it certain definite changes and distortions of the pelvic bones. The symphysis is separated in many instances during the period of gestation and delivery. The sacro-iliac synchondrosis spreads, the ligaments which have as their function the retention of the normal relationship of the articulations become relaxed. Often these distortions are not corrected, an instability of the sacro-iliac and even a slipping of the joints results.

We expect too much from nature. Our patients are permitted after 10 days to be up and about on the presumption that the relaxation which has taken place over a period of months has corrected itself. We can readily imagine what permanent changes must take place after eight or ten pregnancies in that number of years. During my lying-in service our patients after delivery insisted on having very firm binders applied, saying they wished to avoid "high stomachs." This commonplace expression of vanity had a more rational basis, that of holding the pelvic girdle firmly to assist in the rapid restoration of the normal relation of the pelvis.

The true cause of low back pain is prevalent in women as well as men. The same osteo-arthritic changes obtain. Osteospondylitis with its resultant bone changes and its pains and aches is responsible for most of the disability. This inflammatory process coupled with well-known tilting or "torsion" of the fifth lumbar vertebra on the sacrum spells incapacity. Even more distressing is the acute pain which comes from a subluxation or slipping of the sacro-iliacs. You have all seen this type. The patient steps off the curb unexpectedly or suddenly misses a step while going upstairs, or turns suddenly and something happens in the lower spine. Immediately pain results. The patient cannot walk or if she walks at all it is in position with a formed stoop or possibly in a stooped position leaning off to one side or the other.

There are other traumatic conditions which we all see frequently which have their origin from an unusual day's work: standing, stooping, washing, etc.

Postural deformities from bad posture habits, infantile paralysis, rickets, tuberculosis, and a fracture involving the spine must be mentioned.

We often overlook deformities of the lower extremities,, especially those of the feet. Flatfoot deformity means walking with feet in eversion and a change in hips and pelvis. As etiological factors we can enumerate the various foci of infection—teeth, tonsils, sinuses, kidney and bladder involvements and occasionally pelvic infections. Trauma plays no small part in the localization of these foci. With this in view, does not the backache case belong in the realm of the orthopedic surgeon rather than that of the gynecologist?

The management, then, does not often call for the removal of tubes, ovaries, or uterus nor can conditions often be relieved by the shortening of the round ligaments nor the anterior fixation operations. It demands a

removal of the cause primarily, then an improvement of posture, a change of habit, dress, and proper adjustment of the various fashions or whims which make for deformed spines and pelvis. These patients need proper plaster casts, braces, or corset braces to correct these deformities and hold the body in proper position until the inflammatory process has subsided. After that a correction of modes of living and then the development of musculature and ligamentous structure by suitable rational exercise so that the skeleton may be properly held in position. In the subacute or acute strains, absolute rest with immobilization is indicated. Women who bear children need our special care and attention; a reasonable length of time must elapse before such patients should be permitted to be up and about at their daily routine. Then and only then will we avoid the disfiguring and painful deformities so often seen in our comparatively young women; only then will we see less of the woman with wide hips and the pendulous abdomen, the woman of thirty-eight with the characteristic complaints and deformities of a grandmother of sixty.

SUMMARY

In my summary then permit me to emphasize:

1. That backache and deformity are due only in rare instances to disease of the pelvic organs.

2. That a careful examination will reveal other causes of pain and will prevent the numerous unnecessary, often unsexing operations all too frequently performed.

3. That a removal of the cause and proper supporting measures will often give complete relief.

4. That the care of backache in women as well as in men is the responsibility of the orthopedist and not the gynecological surgeon.

A CONTRIBUTION TO THE STUDY OF LOW BACK PAIN

By R. RUSSELL BEST, M.D., Omaha, Nebraska
Department of Anatomy, University of Nebraska

A FREQUENT and perplexing problem is the low back strain. In certain cases the patient will get relief in a few days regardless of treatment while in others treatment is followed by slow convalescence or chronic low back pain inhibiting active work. Because of some early failures in the treatment of this condition I was stimulated to further investigation of the problem.

Causes for low back pain may be listed under the following[1]: (1) trauma including sprains, strains, fractures, and dislocations; (2) faulty position with relaxed ligaments and muscles; (3) diseases of the spine and sacro-iliac joint; (4) intra-abdominal and pelvic pathology; (5) skeletal malformation. It is not necessary to dwell at large on these various causes as they have been so well discussed by numerous other writers. It is the purpose of this paper to lay particular emphasis on the muscular mechanism that plays a considerable rôle in low back pain, especially when it is related to injury. A large number of patients give a history of having lifted something beyond their capacity or of having an unexpected load suddenly thrown upon them while lifting. In another group of cases the patient gives a history of carrying on some work in a cramped or faulty position and of working at a mechanical disadvantage. Still others have assumed a faulty attitude because of intra-abdominal or pelvic disease or an old injury or disease of the spine, sacro-iliac joint, or hip joint. Any of these conditions may lead to an excessive sudden or a prologed load upon a certain group of muscles with the result that the patient complains of low back pain, most severe when he attempts to straighten up from the stooped over position or when he arises from the sitting position.

Those muscles which play an important part in keeping man in the erect position are prone to considerable strain when he bends or stoops or attempts to lift a load while in this flexed position. There are two important muscle groups in this category, namely the gluteal group and the sacrospinalis group.

The gluteal group, between the pelvis and the upper extremity of the femur, is probably the one most important group since in bending over the greatest axis of motion is through the hip joint. A special study of this group of muscles was made, both clinically and in the laboratory.

The textbooks in anatomy list only the gluteus maximus as an extensor of the hip. They make no mention of the gluteus medius as an extensor of the hip, simply calling its action, abduction and internal rotation. The problem of determining the function of the gluteal muscles was undertaken. The mechanical device shown in Figure 14 was constructed. The pelvis with the intact hip joint and femur was clamped to the table. The femur was blocked posteriorly so that it could only be brought back to the normal standing position. A cord was attached to the insertion of the muscle and then directed toward the origin of the muscle. The cord instead of being attached to the origin, was run through a hole in the bone at that point and over a pulley across the table where a weight was attached to the end of the cord. The weight kept the cord at constant tension and a needle was so fastened in the cord as to register all movements. When the femur was flexed on the pelvis, the needle indicator held against a chart moved through a distance equal to the elongation of the relaxed muscle. Then on bringing the femur back to the normal standing position the contraction distance was noted. To get the action of groups of muscle fibers in the various parts of the muscle the cord was attached to a number of screws placed at the muscle insertion and the cord permitted to run through a number of holes placed over the origin.

The function of the gluteus maximus was first determined, the cord extending from eight different points of origin to four different points of insertion (Figs. 3 and 4). From the

[1] Classification of Billington.

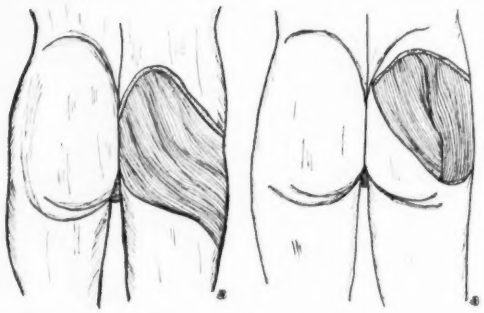

Fig. 1 (left). Gluteus maximus muscle.
Fig. 2. Gluteus medius muscle.

chart (Fig. 5), the following conclusions were drawn:

1. All portions of the gluteus maximus muscle are important in extending the thigh.

2. The muscle fibers attached to the sacrum recorded considerable more contractile distance than those attached to the ilium.

The gluteus medius muscle was then worked out in a similar manner, the cord extending from fourteen different points of origin to four different points of insertion (Figs. 3 and 4). From the chart (Fig. 6) the following conclusions were drawn:

1. The gluteus medius is an important extensor of the thigh although it is not recorded as such in anatomy textbooks.

2. Those fibers attached to the outer half of the ilium and to the upper part of the greater trochanter are the most pronounced extensor fibers. The last fibers mentioned above record almost the same contractile distance as the maximum contraction fibers of the gluteus maximus.

The gluteus minimus was then worked out in a similar manner, the cord extending from twelve points of origin to three points of insertion (Figs. 3 and 4). From the chart (Fig. 7), the following conclusions were drawn:

1. While in extension, some of its fibers probably slightly aid in extension.

2. Most of its fibers aid in flexion when the hip joint is the least bit flexed.

The diagrams in Figures 8 to 13 inclusive are tracings from photographs and show the origin and insertion of the gluteus maximus, medius and minimus, the lines of traction and their relation to the axis of rotation, both in the extended and flexed positions. The lines of traction of both the gluteus maximus and medius in the extended and flexed positions are posterior to the axis of rotation, thereby resulting in the extension function of these muscles. The lines of traction of the gluteus minimus are both anterior and posterior to the axis of rotation and vary in the extended and flexed positions.

With the above knowledge of the functions of the gluteus maximus and medius as extensors of the hip, particular emphasis was placed on the examination of these muscles in all cases with histories of strain, injury, or pain in the lower back region on whom marked tenderness could be found if pressure was made over the gluteus maximus and medius muscles. In a considerable number of cases tenderness could be found only when the patient was asked to bend over and then with both thumbs exerting deep pressure over the glutei, the patient assumed the erect position. Such palpation should include the entire origin of these muscles and the body of the muscles over the ilium.

Myositis as an entity and particularly gluteal myositis seldom receives attention in the many articles dealing with low back pain. I believe the condition is frequently present in those who have had back strain, who work at a mechanical disadvantage, or whose equilibrium has been disturbed.

Every joint depends for support against continuous strain on the ligaments but for all motion on the muscles. It is the muscle with its fascial attachments and tendons that assumes the rôle of the first protective barrier in movement. In the region of the sacro-iliac joint although large bundles of muscular fibers are not present, yet their fascia form a network over the sacro-iliac joint and this fascia muscular mechanism must in many instances receive the primary and only injury. Notwithstanding the fact that a freely movable (diarthrodeal) joint depends for its integrity in motion primarily on its muscle mechanism and when the muscles are thrown off guard or do not coordinate on the ligaments, yet in many so-called sprained ankles, the pathological change

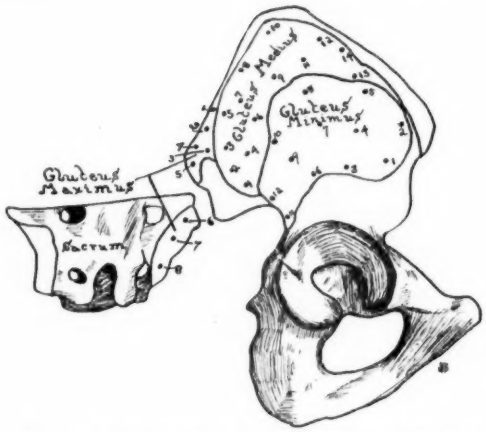

Fig. 3. Showing origin of gluteus maximus, medius and minimus on ilium and sacrum. Numbers correspond to those on charts in Figures 5 to 7.

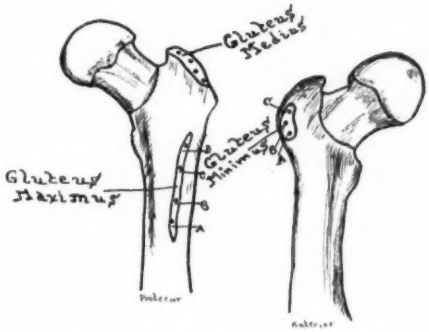

Fig. 4. Showing insertion of gluteus maximus, medius and minimus on femur. Letters correspond to those on charts in Figures 5 to 7.

is probably not in the ligaments but in the surrounding tendons and the tendon sheaths which have sustained the first shock. The lateral and medial ligaments of a freely movable joint such as the ankle may be compared to the sacro-iliac ligaments and the tendons to the muscle and fascia over and around the sacro-iliac joint. The muscles and fascia around this joint must in many instances receive the strain of the axis of rotation through the hip joint. This is true in cases in which one is attempting to lift a load beyond his capacity. A sudden or unexpected load will also throw the load on the muscle mechanism.

Man in the process of stooping over to pick up an object flexes the pelvis on the thigh. He goes through the same flexion movement when he seats himself on a chair. To get up from the sitting position or to straighten up from a stooped-over position, he uses more than any others the gluteal muscles. It is these muscles that are the pulling force against the load when the center of gravity has been placed in front of the perpendicular axis.

It is not the purpose of this paper to condemn the diagnosis of sacro-iliac disease. This condition probably exists, but not as frequently as the diagnosis is made. Sacro-iliac disease has received wide attention and the diagnosis has become so popular that many other equally severe conditions have been overlooked. I believe the sacro-iliac joint is a potential joint inasmuch as it has a synovial membrane and an articular cartilage. It probably possesses no normal movements, yet it may assume abnormal ones which may possibly result in subluxation. Contrary to the opinion of some previous writers the sacrospinalis muscle and the gluteal muscles are not antagonistic muscles tending to separate the sacrum and ilium. The sacrospinalis with its attachments to the sacrum and ilium and the glutei with their origins on both the sacrum and ilium tend to support rather than separate the joint. It would seem that more injuries would be in the lumbar region. This is due to the fact that above the lumbar vertebræ, there is the support of ribs and their muscles for the vertebral column. In the lumbar region the ribs are absent and there is no lateral bony support for the vertebral column. Below the lumbar region there is the bony pelvis. These joints being in the lumbar region, with less support, and more freely movable, are probably subject to more frequent injury from strains than the sacro-iliac joint. Though the lumbar joints are frequently the seat of injury, the trauma and injury to the muscles which protect the joints must not be forgotten. The sacro-spinalis muscle must receive some injury in most lumbar strains and in some instances be the only lesion.

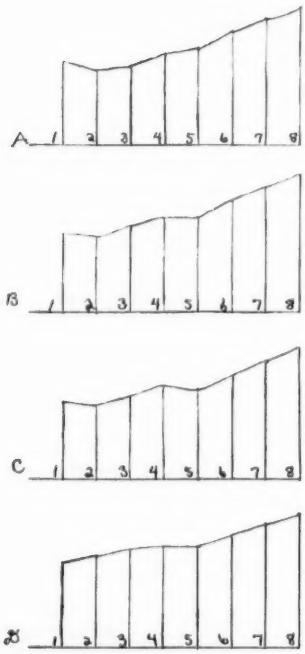

Fig. 5. Chart showing degrees of extension of various parts of the gluteus maximus muscle. The needle indicator always moved upward from the base line proving the muscle to be an extensor of the hip joint.

In the dissecting room the appearance of the position of the sacrospinalis muscle led me to believe that this muscle bridging over the lumbar region between the lower ribs and pelvis was subject to considerable strain. To prove this, the apparatus shown in Figure 15 was used in the examination of the hypothesis.

This apparatus is similar to that described in the experiment with the gluteal muscles. In addition, the flexible spinal column is represented by a long spring made of No. 8 spring steel wire. The spring is flexible and it can be made to closely simulate the movements of the spinal column. The long upper transverse wires which have been screwed onto the spring represent the ribs. The shorter lower transverse wires represent the transverse processes of the lumbar vertebræ.

The sacrospinalis muscle with its various component parts is rather complicated in its structure and attachments. It is placed on either side of the vertebral column extending from the sacral to the cervical regions (Fig. 16). Below it is attached to the sacrum, ilium, spines of sacrum, lumbar and thoracic vertebræ, supraspinous ligaments, and sacro-iliac ligaments. Above, its various component parts are attached to the ribs and transverse processes of the vertebræ.

A cord was extended from the ribs and transverse processes to small holes in the upper part of the ilium and to a pulley across the table where a weight was attached. This is along the line of traction of the muscle. A wire indicator attached to the cord moved across the chart. Although the sacrospinalis muscle was not worked out in detail as with the gluteal muscles yet it was definitely demonstrated that the sacrospinalis is an important extensor muscle of the vertebral column and due probably to its above described position is subject to considerable strain. All patients with low back pain were examined for injury of this muscle.

The pathology found in traumatic myositis is rather obscure. What occurs is probably a laceration of muscle fibers and of fascia, varying degrees of hæmorrhage, and malposition of structures. It is rather difficult to get material for scientific investigation.

If the patient has a focus of infection at the time of injury, it is possible that a secondary infection myositis will present itself. I have had a number of cases in which the condition did not improve as rapidly as might be expected until foci of infection had been removed, when rapid improvement followed.

The recognition of low back strain is not easy. The triumvirate in the diagnosis of conditions of the low back region associated with trauma are myositis (of the gluteal and sacrospinalis muscles), lumbosacral strains, and sacro-iliac strains. However we must always be on the alert for the detection of fractures and dislocations, osteo-arthritis, static backache, congenital anomalies, sacro-iliac disease, sciatica, tuberculosis, syphilis, primary or metastatic neoplasm, toxæmia, and focal infection.

A definite routine should be followed in the examination of every case of back injury.

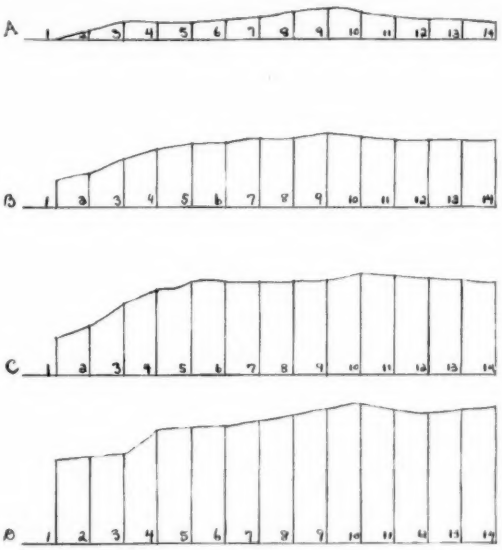

Fig. 6. Chart showing degrees of extension of various parts of gluteus medius muscle. The needle indicator always moved upward from the base line proving the muscle to be an extensor of the hip joint.

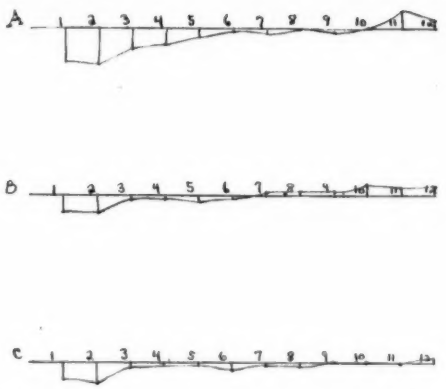

Fig. 7. Chart showing degrees of motion of the gluteus minimus muscle. The needle indicator tended to move downward or remained stationary, proving that the muscle was a weak flexor of the hip joint when hip was in flexed position.

It is helpful to get a history of just how the injury occurred and to what extent of straining the back has been subjected. It is probable that many of the cases of both mild and severe trauma result in muscular injuries. The sacro-iliac cases usually follow severe trauma, the lumbosacral cases do not.

Palpation for tenderness should be complete. It is well to begin at some definite point and proceed in some definite systematic manner. I have found the posterior superior spine most helpful as a bony landmark and beginning at this point palpate for tenderness over the gluteus maximus and medius muscles (Figs. 1 and 2), and the sacrospinalis muscles (Fig. 16). I then palpate for tenderness over the lumbar vertebræ and sacrum, and lay particular emphasis on the lumbosacral joint which is just medial and above the posterior superior spines. Attention must then be directed to the sacro-iliac ligaments, iliolumbar ligaments, and the sacro-iliac joint.

The greatest amount of information is received from palpation for motion tenderness or what I prefer to call function tenderness. It is helpful to divide motion into the three different positions: standing, sitting, and lying.

1. Motion standing: I palpate for function tenderness by deep pressure over the gluteal muscles as the patient straightens up from the stooped-over position. If there is a gluteal myositis or possible traumatic neuritis or bursitis, the patient will complain of much more pain than when asked to straighten up without applied pressure on the gluteal muscles. Cases of gluteal myositis may result in so much spasm as to simulate either sacro-iliac or lumbosacral strain. Injuries of the sacrospinalis muscle will show rigidity of the spine and function tenderness on bending. The lumbar region will be held rigid by muscle spasm if the condition is lumbosacral, flexion will take place at the hips, upper lumbar spine and dorsal regions. In sacro-iliac conditions the patient is apt to bend forward by flexion of the lumbar spine.

2. Motion sitting: A patient with a gluteal myositis will complain of moderate pain upon assuming the sitting position, more marked however upon arising from the sitting position because of the functioning gluteus maximus and medius muscles. In a case of myositis of the sacrospinalis muscle the spine is held rigid and there is function

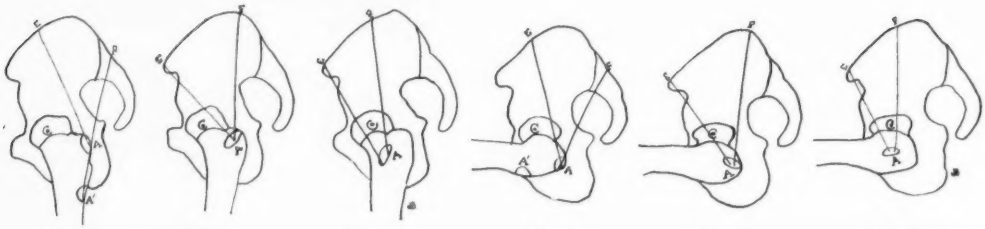

Fig. 8. Fig. 9. Fig. 10. Fig. 11. Fig. 12. Fig. 13.

Fig. 9. Gluteus maximus with hip extended, shows extension by entire muscle. *E-F* is the origin of gluteus maximus. *A* and *A'* functional insertions. *E-A* and *F-A-A'* are lines of traction. *C* is center of rotation.

Fig. 10. Gluteus medius with hip extended, shows extension by entire muscle. *E-F* is origin of gluteus medius. *A* is functional insertion. *E-A* and *F-A* are lines of traction. *C* is center of rotation.

Fig. 11. Gluteus minimus with hip extended shows that extensor and flexor fibers probably equal each other. *E-F* is origin of gluteus minimus. A is functional insertion. *E-A* and *F-A* are lines of traction. *C* is center of rotation.

Fig. 12. Gluteus maximus with hip flexed shows extension by entire muscle. *E-F* is origin of gluteus maximus. *A* is functional insertion. *E-A* and *F-A* are lines of traction. *C* is center of rotation. A' is anatomical insertion.

Fig. 13. Gluteus medius with hip flexed shows extension by entire muscle except for a few anterior fibers which apparently do not act as extensors or flexors. *E-F* is origin of gluteus medius. *A* is functional insertion. *E-A* and *F-A* are lines of traction. *C* is center of rotation.

Fig. 14. Gluteus minimus with hip flexed shows flexion by greater part of muscle, a few fibers are apparent extensors. *A-F* is origin of gluteus minimus. *A* is functional insertion. *E-A* and *F-A* are lines of traction. *C* is center of rotation.

tenderness just as in the standing position. In sacro-iliac conditions it is quite remarkable how freely a patient may bend forward from the sitting position. In lumbosacral conditions, the attempt to flex the spine while in the sitting position is just as limited as while in the standing position.

3. Motion lying: This may be divided into flexing the thigh with the knee flexed and with the knee extended. Gluteal myositis may give pain when the leg is raised in the flexed and straight position and particularly when the hip is brought back into extension. This procedure may or may not result in pain when the sacrospinalis muscle has been injured. With the knee flexed, muscle leverage on the pelvis is eliminated to some extent and sacro-iliac conditions frequently are free from pain but in lumbosacral conditions, pain is usually present. With the leg straight, flexing the hip joint gives rise to pain in both sacro-iliac and lumbosacral conditions. This examination should be done with one hand under the lumbar spine. If pain is brought on early in the act of straight leg raising, that is before the lumbar spine begins to move, the appearance of pain is in favor of sacro-iliac disease. If there is no pain until the lumbar spine begins to move, evidence is in favor of lumbosacral disease, although both sacro-iliac and lumbosacral disease may give rise to pain at this stage of

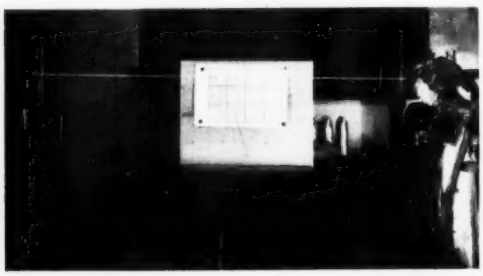

Fig. 14. Apparatus used in the experiment on gluteal muscle.

Fig. 15. Apparatus used in the experiment on sacrospinalis muscle.

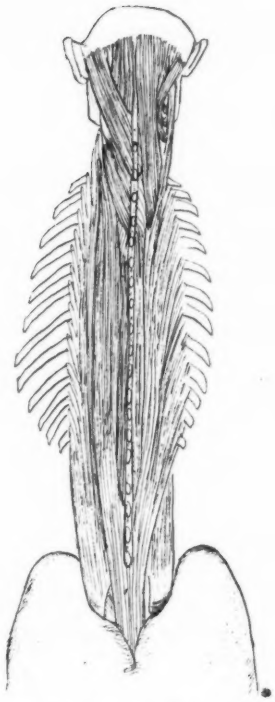

Fig. 16. Sacrospinalis muscle.

straight leg raising. The conditions on the two sides must be compared.

Compression of the iliac crests by placing the injured side on the table and pressing on the other iliac crest with the body weight should be done in all low back cases for evidence of sacro-iliac disease and fractures.

Probably no examination is complete without the X-ray and really no criticism should follow its extensive use. However, the X-ray is usually essential only in the more severe types of injury or those in which convalescence is slow and a check up on the condition of the bone is essential.

Less emphasis should be placed on spinal anomalies and abnormal outlines, especially from the patient's standpoint, when they have no bearing on the treatment of the injury. Osgood reports that 50 per cent of the plates taken at the Massachusetts General Hospital for various troubles did not show normal outlines of the back region.

Fig. 17. Correct strapping for gluteal myositis. The superficial diagonal strips indicate direction of deeper strips.

The treatment of gluteal myositis is correct strapping of the gluteal muscle, thereby attempting to give some protection to the muscle, to be supplemented by baking and massage. After having made the diagnosis, the gluteal region is strapped as shown in Figure 17. The principle is to extend the adhesive tape from well up on one lumbar region, diagonally down and across to the lateral border of the opposite thigh over the region of the trochanters. These strips tend to follow the line of traction. A few horizontal strips of adhesive are placed across the gluteal region and the lumbar region. If the sacrospinalis muscles show evidence of injury, the transverse adhesive strips must begin just above the level of the trochanters and extend up as high as the lower ribs. Long, wide, diagonal strips crossing over the lumbosacral junction give additional support.

After the patient has been correctly strapped, he is asked to take a hot sitz bath 2 or 3 nights later at which time he is to remove the adhesive. The hot bath not only serves as a means for applying heat to an injured region and relaxing muscular spasm, but also serves to make more easy the removal of the adhesive. The morning following the removal of the adhesive, the patient is asked to return to the office where he is put under a cradle baking machine for 15 to 30 minutes. Following this the gluteal muscles and sacrospinalis muscles are massaged. The massage must not be too vigorous yet it should be sufficient to cause some discomfort to the patient. It is rather striking how patients will at times arise from the table remarking how much better they feel. The patient is then strapped as before except less adhesive support is used. The patient is asked to repeat the bath two or three nights later, remove the adhesive, and return the next morning for baking and massage. In many of the patients the condition will have cleared up by this time, while in others it may or may not be necessary to apply more adhesive support and to continue baking and massage. It all depends upon the severity of the case.

It is not in the scope of this paper to discuss in detail the treatment of all low back cases. The treatment of sacro-iliac and lumbosacral strains has been well covered in many other papers. Either condition demands all the possible immobilization with either strapping with adhesive, various types of corsets or belts or plaster-of-paris jackets, depending on the chronicity and severity of the case. The essential factor in providing a protective mechanism for the sacro-iliac joint is to be sure that the pressure is exerted over the level of the trochanters of the thigh. Pressure on the iliac crests tends to separate rather than oppose joint surfaces and to strain the ligaments rather than offer protection. The lumbosacral strain should secure support extending from the trochanters up to and beyond the lower border of the ribs. Both of these conditions should be supplemented by baking and massage.

The strapping, if correctly applied, tends to support and splint the injured muscles. In many of these low back strains whether an acute or chronic condition, there have been strains or tears of the muscles, their aponeuroses, fascial attachments or ligaments. As a protective response and as a result of traumatic irritation, the injury is followed by muscular spasm. This muscular spasm of injured tissue may result in malposition of muscle fasciculæ, fascia, aponeurosis, or ligaments which condition is crippling and painful. It is this type of case which responds to the treatment of the various cults. It can do little harm to attempt by a little massage or manipulation to effect a restoration of normal relations. We shall often be rewarded by a surprising sudden relief of symptoms and a relaxation of the originally protective and subsequently locking muscle spasm.

The baking is a valuable adjuvant, relieves pain, relaxes muscular spasm, and increases the blood supply to an injured area.

SUMMARY

The gluteus maximus and medius muscles are extensors of the hip. This function of the gluteus medius is not described in anatomy textbooks.

Traumatic myositis of the gluteus maximus, medius, and sacrospinalis muscles is a frequent condition.

Correct strapping supplemented by baking and massage will relieve the condition.

A HUMAN OVUM APPROXIMATELY NINETEEN DAYS OLD[1]

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EXACTLY fifty human ova less than 3 weeks old have been described more or less thoroughly during the last five decades. This means that the series of young human ova is far from complete and because of the inadequacy of our understanding of the early stages of development, a detailed description of all young ova is justifiable.

The ovum here described presents certain peculiarities in growth which have not previously been emphasized. It was obtained by Dr. D. W. Day of Rockford, Illinois, from a decidual cast expelled on October 31, 1918. The patient had had four spontaneous full term labors and had never had any miscarriages. Her menses had always been regular and recurred every 28 days. The menstrual period which began on August 18, 1918, was unusual because the flow was exceptionally profuse. In September the flow was expected on the fifteenth, appeared on the sixteenth and lasted only a few hours. On October 2, the patient was overcome by illuminating gas from which she recovered. On October 20, she became ill with influenza. On October 30, bleeding from the uterus occurred and the decidual cast was expelled spontaneously, 73 days after the last normal menstrual period and 44 days after the slight flow in September. The development of the ovum, however, indicates that it belongs to a group of ova with much shorter menstrual ages, as will be proved in the discussion on age. The cast was placed in 10 per cent formalin, 3½ hours after it had been expelled and was received on November 5, 1918. It is designated as H518 in the Embryological Collection of the Department of Anatomy, the University of Chicago.

GROSS SPECIMEN

The cast, which was pear-shaped and measured 46 by 33 by 7 millimeters, was opened and the implantation site was photographed (Fig. 1). The cervical end of the cast was easily distinguishable from the part which had been in the fundus of the uterus. Near the junction of these two distinct portions was an intact oval elevation which protruded into the uterine lumen. This elevation, which contained the ovum, measured about 9.4 millimeters in length, 7.3 millimeters in width, and 3 millimeters in height and the entire decidua at this site was 6.3 millimeters high. One spot in the elevation appeared more translucent than the surrounding tissue. As will be described later, this represented the point of entrance of the fertilized ovum. The surface of the decidua vera was furrowed.

DECIDUA

Decidua is defined as uterine mucosa in the presence of pregnancy. We distinguish four types, namely, (1) decidua basalis which is that part on which the ovum rests and from which the ovum receives most of its nourishment, (2) decidua marginalis which surrounds the ovum equatorially, (3) decidua capsularis which forms the roof of the implantation cavity, and (4) decidua vera which is at a distance from the ovum.

Decidua basalis. The portion of the decidua basalis which immediately borders on the implantation cavity differs from the remainder of the basalis. It is separated from the implantation cavity by an almost continuous layer of fibrinoid[2] and is known in the literature by a variety of names but we shall call it the penetration zone and describe it with the trophoblast.

The decidual change which is found in early ova is very variable. In our specimen, the cells below the penetration zone show the typical decidual change. They are essentially large, polygonal, pale cells with large ovoid nuclei but some cells are round or spindle-

[2] Many writers use the term "fibrin" to designate both fibrin and fibrinoid. However, as Grosser points out, the term fibrin should be used only for the coagulum which arises from blood, lymph, or tissue juice. On the other hand, fibrinoid arises chiefly from trophoblast but also from degenerated maternal tissue.

[1] Read before the Chicago Gynecological Society, March 18, 1927. A complete description of this ovum will appear in the American Journal of Anatomy. From the Hull Laboratory of Anatomy of the University of Chicago.

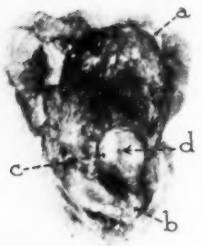

Fig. 1. Photograph showing decidual cast opened. *a*, Fundal end; *b*, cervical end; *c*, ovum; *d*, operculum.

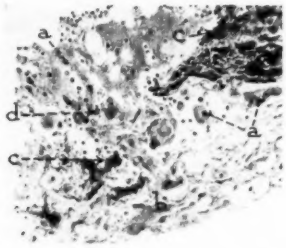

Fig. 4. Invasion of decidua by plasmodium. *a*, Plasmodium; *b*, penetration zone of decidua basalis; *c*, fibrinoid; *d*, pigment.

shaped. Scattered throughout the basalis are leucocytes. The glands in the basalis are narrow and run obliquely. Near the ovum they are almost parallel with the long axis of the implantation cavity (Figs. 2 and 8). Most of the glands resemble those seen in the early premenstrual phase. Only an occasional gland shows the typical "saw-toothed" change of pregnancy, the so-called pregnancy gland of Opitz. Nearly all the glands appear empty and but few of them show marked secretory activity. In most places the epithelial cells of the glands are cuboidal, they have granular protoplasm and they contain large, pale nuclei. The total number of glands is strikingly small.

Decidua marginalis. The marginalis is similar to the basalis but the decidual changes, except very near the implantation cavity, are not so pronounced.

The blood vessels in the decidua beneath and to the sides of the implantation cavity are numerous and consist chiefly of veins (Figs. 2 and 5). Almost all the veins are dilated and contain free blood or fibrin or both. Most of the arteries are narrow and spiral-shaped and contain very little blood. The walls of most of the veins consist of a layer of endothelium and an outer thin layer of connective tissue. The arteries, on the other hand, have not only an endothelial but also a well-defined musculo-fibrous layer.

There are many communications between the implantation cavity and maternal veins. A very careful study was made to find arterioles which open into the implantation

Fig. 2. Photograph showing general view of ovum. *a*, Chorion læve; *d*, chorion frondosum; *c*, blood in implantation cavity; *d*, implantation cavity or intervillous space; *e*, decidua basalis; *f*, decidua capsularis; *g*, gland; *h*, vein; *j*, curved vein.

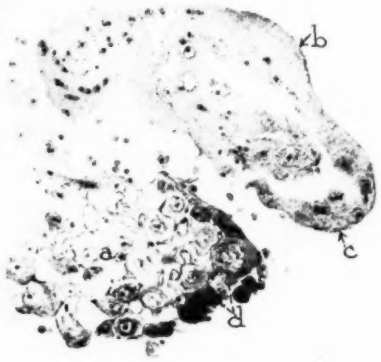

Fig. 3. Photograph of drawing showing cytoblast, plasmodium, and transition stages. *a*, Cytoblast; *b*, plasmodium; *c*, brush border; *d*, transition stage. In this photograph the transition stages are particularly well illustrated.

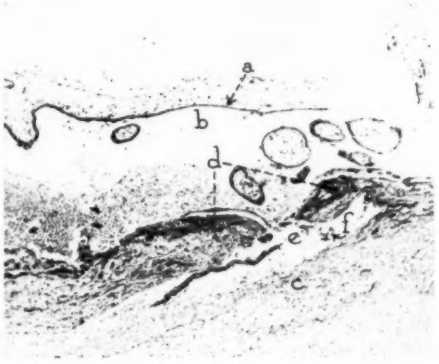

Fig. 5. Photograph showing invasion of blood vessel by plasmodium. *a*, Chorionic vesicle; *b*, intervillous space; *c*, decidua basalis; *d*, fibrinoid; *e*, vein; *f*, plasmodium.

cavity and while some arterioles were found coming close to the implantation chamber, none were found actually to communicate with it. We can, therefore, say definitely that large arterioles do not enter the intervillous space even at this early stage.

Immediately adjacent to the side of the implantation cavity are glands and veins curved like arcs which correspond with the curve of the implantation cavity (Fig. 2). These curves are undoubtedly due to pressure of the growing ovum. The glands resist invasion of the plasmodium in contrast to the veins which are very susceptible to invasion by plasmodium.

Decidua capsularis. The structure of the capsularis is hard to distinguish in most areas but in general the tissue consists of degenerated decidual cells with fibrinoid, blood vessels, a moderate number of red blood cells, many leucocytes, pigment and vacuoles scattered throughout. The nearer the implantation cavity, the more necrotic is the tissue of the decidua capsularis, the more deeply it stains and the more fibrinoid it contains. Most of the capsularis has no epithelial covering and in our specimen no glands were seen anywhere. In a few areas the capsularis is invaded by plasmodial masses coming from the implantation cavity. In one place, a thin strand of plasmodium is contiguous with the free end of the endothelium of a blood capillary (Fig. 6).

Fig. 6. Photograph showing plasmodium in contact with maternal endothelium. *a*, Plasmodium; *b*, endothelium of maternal capillary; *c*, point of contact; *d*, fibrinoid; *e*, brush border; *f*, decidua capsularis; *g*, intervillous space.

Decidua vera. The decidua vera contains numerous glands resembling those of the premenstrual phase and abundant arteries and veins.

CHORIONIC VESICLE, VILLI, AND IMPLANTATION CAVITY

The following is a list of the measurements of our ovum. All the measurements are maximum ones and they are given in the following order: (a) the measurement parallel with the long axis of the uterus, (b) the

Fig. 7. Photograph showing operculum deciduæ. *a*, Decidua capsularis; *b*, operculum deciduæ; *c*, plasmodium; *d*, piece of chorionic ectoderm; *e*, intervillous space

Fig. 8. Photograph showing body stalk and amnion. *a*, Chorionic vesicle; *b*, implantation cavity; *c*, body stalk; *d*, amnion; *e*, trophoblast; *f*, gland.

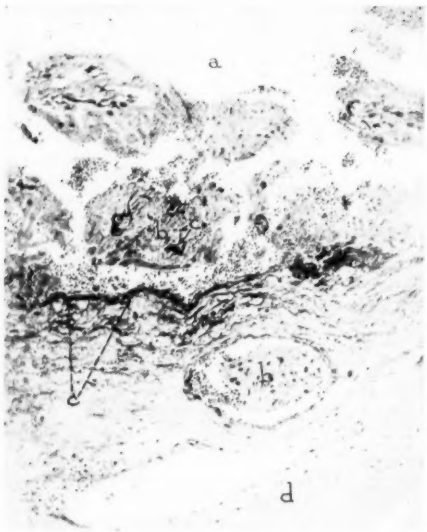

Fig. 9. Photograph showing plasmodium in blood vessel and in intervillous space. *a*, Intervillous space; *b*, plasmodium; *c*, fibrinoid; *d*, decidua basalis.

measurement perpendicular to the long axis of the uterus, and (c) the measurement perpendicular to the mucous membrane.

1. The ovum including the decidua capsularis as a gross specimen in formalin, measured 9.4 by 7.3 by 3.0 millimeters and in the stained sections, 8.37 by 6.44 by 2.67 millimeters.

2. The implantation cavity in the stained sections measured 6.23 by 5.79 by 2.5 millimeters.

3. The ovum with the definitive villi in the stained sections measured 4.72 by 5.41 by 2.23 millimeters.

4. The ovum exclusive of villi in the stained sections measured 4.08 by 4.21 by 1.57 millimeters.

5. The embryonic disk (estimated) in the stained sections measured 0.15 by 0.13 millimeters.

6. The yolk sac in the stained sections measured 0.64 by 0.53 by 0.43 millimeters.

The amount of shrinkage in the ovum was only 11 per cent, an unusually small amount and because of this, the ovum appears to be relatively large in comparison to the stage of development it represents.

From the surface of the chorionic vesicle (or blastocyst) which is directed toward the decidua basalis, numerous well-developed villi arise, whereas on the opposite surface, there are comparatively few villi (Fig. 2). There is, therefore, a definite differentiation into a chorion frondosum and a chorion læve. Perhaps this is correlated with a superficial implantation. Some of the villi show budding but the buds themselves do not subdivide.

There is very little magma, the chorionic mesoderm being largely confined to the wall of the blastocyst where it consists of scattered spindle cells. Blood vessel anlagen are seen in the mesoderm of the chorionic vesicle and in a few of the larger villi.

The body stalk, which is a thickening of mesoderm, is situated in the chorionic vesicle basally but excentrically. The allantoic duct which consists of simple cuboidal epithelium extends but a short distance into the body stalk.

In most places the chorionic ectoderm consists of two layers, an inner cytotrophoblast or pre-Langhans layer and an outer syncytial layer. The protoplasm of the former is well differentiated into individual cells and

the nuclei are large, pale, and distributed with some degree of regularity. The outer layer varies considerably in thickness and has elongated and dark-staining nuclei which lie parallel to the surface. Many villi are covered with only one layer of ectoderm and this is usually the syncytial layer. On the tips of some villi the ectoderm is heaped up into a large mass of cytotrophoblast by means of which the villi are occasionally attached to the decidua basalis. There is much trophoblast between the villi and the walls of the implantation chamber (intervillous space). The latter is ovoid in shape and is confined to the decidua compacta. While there is considerable blood in some parts of the implantation cavity (Fig. 2), the latter is by no means filled with formed blood elements, nearly all of which are in a state of good preservation.

Nearly all along the border of the implantation cavity, but mostly at the basalis, is an abundant homogeneous or striped, hyaline-like layer of fibrinoid (Figs. 2, 4, 5, 9). It is essentially a rough boundary line between normal fetal and fairly normal maternal tissue but in a number of places, fibrinoid is seen not only within plasmodium but also on the fetal side of some plasmodial masses (Fig. 9). There is abundant fibrinoid also within the penetration zone and in the decidua capsularis. Like fibrin, it has a conspicuous bright red color when stained with eosin.

TROPHOBLAST AND PENETRATION ZONE

Trophoblast or trophoderm is the fetal ectoderm by means of which an ovum becomes implanted and through which the implantation cavity is enlarged. It also forms the outer layer of the chorionic vesicle and its villi. In our ovum, it is most abundant at the sides of the implantation cavity (Fig. 2). It lies free for the most part but some masses project from the distal ends of villi. The most striking feature of our ovum is the very widespread invasion of maternal tissue by the trophoblast. This invasion is most evident in the decidua which immediately surrounds the ovum but masses of trophoblast are also found within blood vessels at some distance from the ovum.

There are two distinct types of trophoblast, namely cytotrophoblast also known as cytoblast and plasmoditrophoblast, also known as plasmodium or syncytium. The cells of the cytoblast (Fig. 3) are large, pale, finely granular, polygonal or irregularly elliptical and contain vacuoles. The nuclei which are large and pale are essentially ovoid in shape but many are irregular in outline. Most cells have only one nucleus.

The plasmodium (Figs. 3, 4, 9) stains more deeply and seems to be made up of myriads of small, closely-packed granules. There are no cell membranes as in the cytoblast but throughout the plasmodium are scattered large, oval, or irregularly quadrangular nuclei which show bright red nucleoli in the sections stained with Mallory's connective tissue stain.

The cytoblast has long been regarded as an earlier stage in development than the plasmodium but not much evidence has been produced to demonstrate the relationship. Many areas in our ovum show this transition distinctly. The cells of the cytoblast swell, their protoplasm acquires a denser granulation and stains more deeply. The nuclei enlarge and the cell borders disappear (Fig. 3). This change is attributed to contact with the maternal blood.

All the invasion of maternal tissue is by the plasmodium, none by the cytoblast. Most of the invading plasmodium is free from the chorionic plate or villi and most of the invasion takes place in the penetration zone.

In our specimen, the penetration zone is found not only in the decidua basalis but also in the marginalis. It is the dividing line between the fetal and maternal tissue and consists essentially of decidual cells which are in various stages of degeneration and of invading trophoblast. Nearly all the decidua that is adjacent to plasmodial masses is necrotic. A few decidual cells not in contact with plasmodium have pyknotic nuclei and this may be due to the distant action of the plasmodium. In the penetration zone the decidual cells are more œdematous and their structure is less distinct than it is elsewhere in the basalis and marginalis. In addition, there are many phagocytic cells. Scattered

throughout the penetration zone are masses of fibrinoid, clumps of maternal red blood cells, leucocytes, and pigment granules. There are, furthermore, in the penetration zone, the terminal portions of veins which communicate with the implantation cavity.

When a mass of plasmodium invades the maternal tissue it encounters first a layer of fibrinoid. We find all stages in the invasion of the decidua, from a mere contact of plasmodium with the fibrinoid to the stages shown in Figures 4, 5, and 6 in which the fibrinoid has been eroded and ingested and the trophoblast is destroying maternal tissue. In one area where a vein has been invaded, one wall of the vein is replaced by plasmodium. In other veins, which have been invaded, masses of excellently preserved plasmodium are seen, some of them at quite a distance from the implantation cavity (Figs. 5 and 9); hence at this early period, we have deportation of fetal elements into the maternal circulation.

In many plasmodial masses and in some of the syncytium which covers the villi, opaque and yellow pigment granules are seen (Fig. 4). These probably represent the end-products of broken-down red blood cells due to the phagocytic action of plasmodium. The pigment is highly insoluble.

The amount of invasion in our specimen is astonishing. At least 12 different sites are found where the plasmodium has broken through the layer of fibrinoid and invaded the decidua or has broken through the walls of veins. In some areas of sections stained with phosphotungstic acid hæmatoxylin, the union between the decidua and plasmodium is so intimate that only very careful study reveals the boundaries between the fetal and maternal tissues (Fig. 4).

Most of the plasmodium which is free in the implantation cavity and is in contact with blood, has a brush border (Figs. 3 and 6) but the latter is not present everywhere. The plasmodium which invades does not seem to have the brush border except in one place. The brush border may represent a difference between resorbing and invading plasmodium.

In one area of the decidua capsularis a strand of plasmodium coming from the intervillous space is definitely contiguous with the endothelium of a maternal capillary. Both plasmodium and endothelium stain similarly and only with the oil immersion lens could the contact surface be found between the fetal and maternal elements (Fig. 6).

While in most places the two distinct layers of the trophoblast are seen, there are numerous areas where only one layer, usually the plasmodial or syncytial is found. This may be because the cytoblast has not proliferated as rapidly as it has been transformed into syncytium and this is especially true where there has been very active growth. We know that by the fifth month there is very little of the cellular layer left on the villi and the explanation is that the growth phase of the trophoblast has disappeared. However, even at term one may find an occasional Langhans cell.

OPERCULUM DECIDUÆ OR VERSCHLUSS

There is a region where the continuity of the decidua capsularis is interrupted by tissue which differs from the decidua but which resembles plasmodium (Fig. 7). This tissue which was called "Verschluss" by Schlagenhaufer, and Verocay, and to which Teacher recently gave the name of "Operculum Deciduæ" extends through the entire thickness of the capsularis. It is situated excentrically in the capsularis (Fig. 1) and its outer surface is slightly depressed. To its inner surface are attached a small mass of plasmodium with a piece of chorionic membrane torn loose from the ovum. The structure of the operculum is hard to describe. Most of it resembles plasmodium but some areas appear to be granular and ill-defined especially at the periphery. In some places there are pale, irregularly-shaped cells with nuclei which vary considerably in size and shape. The adjoining capsularis stains very deeply and consists almost entirely of a fenestrated fibrinoid which is exactly like the fibrinoid seen in other parts where plasmodium is invading the decidua. In many sections the fibrinoid is found not only on the sides of the operculum but also on its inner surface thereby forming a support on which the

operculum rests. With oil immersion lenses it is definitely seen that the opercular mass is continuous with the chorionic ectoderm and the plasmodial mass attached to its inner surface (Fig. 7). The operculum would, therefore, seem to be fetal in origin and was originally attached to the chorionic vesicle but subsequently tore away. This indicates how firm is the union between ectoderm and operculum. The operculum is an area which represents the last part of the ovum to enter the implantation site and also closes the opening made by the ovum.

EMBRYO

The ovum was opened before dehydration had taken place. This was done under fluid with iridectomy scissors, a binocular microscope being used at a magnification of 10 diameters. A nearly spherical vesicle, identified as a yolk sac, was found floating free in the extra-embryonic cœlom which contained but few delicate strands of magma. The body stalk was also found in situ (Fig. 8). Obviously a break had occurred at the junction of the amniotic vesicle and the body stalk, perhaps during the abortion. The embryo presumably lay spread out on the yolk sac but despite a prolonged study under the most favorable lighting conditions, nothing could be found except an occasional blood island and a nearly circular blister. This proved to be the embryonic disk and its amnion. The yolk sac extends through 43 sections 10 micra thick and has the typical structure of an early yolk sac soon after the appearance of blood islands. The largest section measures 0.64 by 0.53 millimeters. In comparison, the embryonic disk is very small, for it is present in only 15 sections and measures 0.13 millimeters in the fourth section of the series. It is, accordingly, a slightly elongated disk and concave when viewed from above. It would seem probable that the embryo's development was retarded or ceased entirely shortly before the abortion, whereas the membranes continued to develop normally. This is frequently seen in abortive ova. As might be expected from its small size, the embryonic disk shows no sign of a primitive streak or of mesoderm, consisting simply of a pseudostratified columnar epithelium lying upon the yolk sac and passing over more or less abruptly into the amnion. In the region of the embryonic disk the amniotic cavity is exceedingly small. Caudally it would appear that it expands into a rather large vesicle which lies in one side of the body stalk (Fig. 8). This is prolonged as a narrow amniotic duct into the body stalk and ends blindly near its base. The beginning of the allantoic duct can not be made out owing to the distortion in the region where the yolk sac and amniotic vesicles were broken from the body stalk. There is, however, a small spherical vesicle of typical endodermal cells in the body stalk just lateral to the amniotic duct which is undoubtedly the dilated end of the allantois, already separated from the rest of the duct.

AGE OF THE OVUM IN OUR CASE

It has been the custom of nearly all authors who have reported young human ova to give the age of their ova in days. Most authors have stated the age with great assuredness. Such positive assertions should not be made, however, because we have no accurate criteria for determining the age of early ova. Many important factors concerned in human reproduction are as yet not fully understood. For example, the following essential information is lacking: (1) The exact time of ovulation, (2) the exact time of fertilization, (3) the length of time it takes an ovum to traverse the fallopian tube, (4) the length of time ova and spermatozoa can live and be capable of fertilization, (5) the age at which an ovum is ripe enough to implant itself in the endometrium, and (6) the stage in development of the endometrium at which implantation can occur. Furthermore, (7) the clinical data are not reliable in most cases. Hence, even when the time of occurrence of a single fertile coitus is known, the age of an ovum can not be determined with accuracy.

Many authors have determined the age of their ovum by the size of the blastocyst. Streeter (1920), for example, is of the opinion that "in young stages up to the time of appearance of the primitive groove, the size of the chorion, owing to its rapid growth as compared with that of the embryo, appears to

be a consistent index of the development of the ovum. In older specimens it is necessary to take into account also the morphology of embryo and chorion." Peters (1925), like Grosser (1925), Linzenmeier (1914), and others, however, insists that this is fallacious because the blastocyst depends for its size upon the extra-embryonic mesoderm and later upon the size of the amnion, both of which vary considerably. Peters maintains that the age of an ovum depends upon the embryonic anlagen and even this is not absolutely certain. We believe that the most important criterion for seriation should be the stage of development of the embryo, and the activities of the chorion should also be taken into account.

Since the data in only very few young ova are strictly reliable, there is but little to guide us. The best we can usually do is to locate the position of a new ovum in the series of specimens previously described. Bryce and Teacher (1908) were the first to prepare a table of young human ova. They listed twelve ova and in addition to the clinical information (menstruation, coitus, date of abortion or operation and autopsy), used as criteria of age, the total size of the ovum, the size of the blastocyst and where it was known, the size and state of development of the embryo. The ages of these ova vary from 13 to 20 days. In tabulating the ova expelled as abortions they deducted two days from the age of the ovum as obtained from the history, one day for the interval which elapsed between coitus and fertilization and one day for the interval elapsing between the death of the ovum and its discharge as an abortion. In the specimens obtained by operation the second deduction was not made. The first deduction coincides with the belief of Mall (1918) that there was a 24 hour difference between what he called "copulation age" and "fertilization age." Grosser (1925) on the other hand, does not make the first deduction in his tables because he believes that the time of coitus, ovulation, and fertilization practically coincides in most cases. Teacher in his last contribution (1925) agrees that fertilization normally occurs within an hour or two of insemination and also that implantation of the ovum more probably takes place on the tenth instead of the seventh day as he formerly believed. The evidence for these conclusions is most inadequate and tables of age must be taken for what they are worth. In addition to the tables of Bryce-Teacher (1908) and Grosser (1925), other valuable charts are those of Streeter (1920), von Moellendorff (1921), and Bartelmez and Evans (1926). Where crucial clinical data were stated by authors, Streeter in his charts conservatively gives the "probable age" and the "possible duration of pregnancy."

As may readily be seen from the above discussion, there is no unanimity of opinion among authors as to the proper way of determining the age of a given ovum and the reasons are obvious. There are too many unknown factors. However, as above mentioned, maximum and minimum ages for certain ova have been determined as accurately as is possible and by comparing the development of a new ovum with that of the known listed ova, we can, with some degree of accuracy, determine the age of the new ovum. However, here again we may err somewhat for it does not follow that ova of the same stage of development are necessarily of the same age. We know that there are variations in growth in extra-uterine life and late in intra-uterine existence. Perhaps there is an appreciable difference in the rate of growth in the very early stages also.

Let us consider our ovum for example. According to the history, the decidual cast containing the ovum was expelled 73 days after the last normal menstrual period. Even if we consider as a menstrual flow, the slight flow of blood which the patient had 29 days after the last regular menses, there is still an interval of 44 days between this bleeding and the expulsion of the decidual cast. Nevertheless the development of our ovum clearly belongs in the group listed as 19 day ova by Grosser (1925) and considered to be still younger by Bryce and Teacher, Streeter and von Moellendorff. If we rely upon the menstrual history, our ovum must have grown very slowly or reached a certain stage of development (19 days) and then

stopped. The excellent state of preservation of the chorion and the embryo would militate against the supposition that the ovum had been dead for a long time before expulsion. Even if we allow the maximum of 3 weeks between menstruation and fertilization there would still be an interval of either 52 days or 23 days between fertilization and expulsion of the ovum. Granting that the latter figure is correct, our ovum must have grown slowly because its development is similar to that of the 19 day ova. Unfortunately we have no coital history but it is of course, possible, that the successful coitus took place 20 days before the expulsion of the decidual cast. This would mean that the fruitful coitus occurred 53 days after the last regular menses or 24 days after the slight bleeding in September. The illuminating gas accident occurred 45 days after the August menses and 16 days after the September show of blood. If the patient were not pregnant in September, why the almost entire absence of the menstrual flow? There are two possibilities. One is that the ovum grew much more slowly than nearly all the reported ova and that its stage of development is that of the ova considered to have a maximum age of 19 days. The other is that for some reason the patient had an amenorrhœa during which she conceived.

Considering the small amount of shrinkage (11 per cent), the measurements as determined from the sectioned material, place the ovum among the youngest of Grosser's 19 day group.

SUMMARY

A young human ovum obtained in an aborted decidual cast, is described and the measurements are given. The outstanding feature of this ovum is the unusual amount of invasion of the decidua by plasmodium. There is very abundant trophoblast, especially plasmoditrophoblast, in the intervillous space. There are numerous definitive villi, some of which have begun to branch. Blood vessel anlagen are found in the mesoderm of the chorionic vesicle, the villi, the body stalk and the yolk sac. The few preserved sections of the embryo show a small amniotic vesicle and an embryonic shield lying upon a large yolk sac. In the decidua capsularis is an operculum deciduæ (Teacher, 1925) which appears to consist of fetal ectoderm and is attached to the chorion læve by a strand of plasmodium. The decidual reaction is more pronounced in the stroma cells than in the glands. Some of the large veins in the spongiosa beneath the ovum communicate with the intervillous space and contain free masses of plasmodium. The development of our ovum tallies with ova considered to have a maximum age of 19 days.

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CYSTOGRAPHY[1]

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THE roentgenological study of the bladder that has been rendered opaque with a medium impermeable to the roentgen ray antedates pyelography by a number of years. It is interesting to note that, while technical difficulties incident to pyelography have largely been surmounted, cystography, a much simpler procedure, has advanced less rapidly. An analogy of the importance and value of the two is inequitable, yet a procedure which involves no greater technical difficulty than that encountered in the aseptic catheterization of the bladder and which is frequently the only source of information concerning disease involving the bladder, should be more generally employed. Cystography is not intended to supplant ocular inspection of the bladder, but to corroborate the cystoscopic findings and to ascertain data which may not be acquired by means of cystoscopy. Also, when the general condition of the patient or technical difficulties of instrumentation preclude cystoscopy, cystography alone may yield the desired information. It is particularly valuable in ascertaining the extent and treatment of neoplasm, in recognizing diverticula, their size and ability to empty, and in demonstrating vesical obstruction, deformity from extravesical pressure, and reflux or regurgitation.

The first attempt to outline the bladder by means of an opaque medium was made by von Zeissel (1902) who experimented on cadavers. Kellar (1904 and 1905) distended the bladder with air and then made roentgenograms in order to portray diverticulum of the bladder. It remained for Voelcker and von Lichtenberg (1906) to demonstrate the possibility of using colloidal silver suspensions as a cystographic as well as a pyelographic medium. Legueu and Papin (1912) published the first complete consideration of cystography and were early advocates of its diagnostic value. They claim priority for its use in the diagnosis of neoplasm. Kelly and Lewis, of Baltimore, and Zuckerkandl, of Vienna (1913), working independently, recorded their observations concerning the value of cystograms in the study of vesical neoplasm. In 1912 we commenced to use cystography as a means of determining the nature and extent of diverticulum, and since then its value has been more fully appreciated and its use extended to the diagnosis of other vesical lesions. Legueu and Papin say they were the first to observe regurgitation of the contents of the bladder into the ureter by means of cystography. Thomas (1916) emphasized the importance of lateral cystograms in the diagnosis of diverticulum of the bladder. Kretschmer (1916) presented an excellent detailed description of cystography together with its diagnostic value and limitations. He recognized the importance of examining the patient with the fluoroscope prior to making roentgenograms and was probably the first to note that regurgitation of fluid into the ureter may occur in children with normal bladders. Bumpus (1924) re-emphasized the value of cystography as an aid in the diagnosis of lesions of the bladder. Coutts has recently revived interest in the value of cystograms made with the patient in the dorsolateral position as practiced by Lerche, Sgalitzer and Hrgntschak, and Marion. The method has not as yet been widely used.

The opaque medium employed in making cystograms has not been standardized. Practically all of the various mediums suggested for pyelography have been used. Suspensions of bismuth subnitrate and barium sulphate have been utilized by European workers, notably Papin, Gangelen, and Uray. Pfister suggested the possible danger of stone formation from the retention of particles of these salts in the bladder, although such an occurrence has not been reported. More recently the preparations of iodized oil, particularly the 40 per cent preparation, as advocated by Sicard and Forestier, have gained popularity.

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Many urologists continue to use solutions of the halogens but the intense burning that often follows precludes their use in the inflamed bladder. A 5 per cent emulsion of silver iodide was suggested by Kelly (1913). This is the medium of choice at the Mayo Clinic, as it not only serves as an excellent contrast medium but as a soothing and antiseptic agent.

"Pneumocystoradiography," or distention of the bladder by means of air or gas, is used considerably abroad, although not generally in this country. It is objectionable because of the accompanying pain from overdistention, the danger of emphysema of the surrounding tissues, and the uncertainty of the outline, which must often be distinguished from that caused by gas in the bowel. The use of oxygen perhaps minimizes these objections. Nevertheless, the cystograms resulting are not usually as satisfactory as those obtained by an opaque medium. Rosenstein proposes to distend the space of Retzius with air or gas as well as the bladder in order to demonstrate more clearly the kind and extent of the vesical lesion, thus making the wall of the bladder visible. The bladder can be filled with opaque medium in place of air or gas. Pfahler (1919 and 1924) reviewed favorably his experience with pneumocystoradiography in the diagnosis of neoplasm of the bladder.

The technique of making serial cystograms by distending the bladder with opaque medium and making roentgenograms at different angles has for years been the method of choice. It has been used at the Mayo Clinic for the last 10 years. Hinman (1919) and Herbst (1924) describe a method in which the bladder, after being emptied of urine, is distended with opaque medium (15 per cent sodium iodide) and a roentgenogram made. The bladder is then emptied of contrast medium by means of a catheter and air immediately injected. A second roentgenogram is then made. This shows retention diverticula sharply outlined by the retained contrast fluid, the bladder being dark from the presence of injected air. Kretschmer used a modified method in which the ureteral catheter is coiled in the diverticulum and the medium injected. Gas or air is injected into the bladder for contrast medium. In 1924 La Rose proposed a method of portraying diverticulum by using an opaque medium of different density. The bladder is first emptied and then filled with a 15 per cent solution of sodium iodide; the patient is turned from side to side in order to fill the diverticulum; the excess medium in the bladder is withdrawn, and the bladder again distended with 0.5 per cent solution of sodium iodide; stereoscopic films are then made.

While various radiographic techniques have been suggested, the following has given satisfactory results: simple roentgenograms of the bladder area are made prior to cystography in all cases. Three film exposures give a series of cystograms which aid in the identification of lesions of the bladder. The first two films are made with the bladder fully distended with 5 per cent emulsion of silver iodide and the urethral catheter withdrawn. The patient is placed in the reverse Trendelenburg position, with the table at an angle of 10 degrees toward the foot. The Coolidge tube is placed at an angle of 5 degrees, which makes a total of 15 degrees inclination toward the foot. The tube is also tilted at an angle of 8 degrees to each side in order to secure lateral exposures, similar to making stereoscopic views. The two lateral views at opposite angles appear to portray more clearly the position of diverticula and defects than does a single film in the vertical plane. When the bladder is emptied preparatory to taking the third film no pressure is exerted. It is safer to rely on catheterization to remove the contents of the bladder than on the patient's efforts. In cases of extensive intravesical hypertrophy of the prostate it may be impossible to empty the bladder completely, a certain amount remaining in the base as a crescent in the third film. No effort to empty the bladder by pressure with the cone or the hand over the symphysis pubis should be made as this may lead to distortion of an otherwise normal cystogram or to the emptying of a diverticulum. The third film is made with the bladder empty, the table being tilted 10 degrees with a 5-degree angulation of the Coolidge tube, making this also an angle of 15 degrees. This film is made in the anteroposterior position without any lateral angulation of the tube. When the legs are supported

in the stirrups of the cystoscopic table (with the patient in the usual position for cystoscopy) the combined angulation of 15 degrees causes the pubic bones to be thrown forward, permitting a much more complete view of the bladder outline. At no time is compression made with the cone. The first two films are exposed 4½ seconds, the third film 4 seconds, and the film voltage is stepped down 2 kilovolts; a 30 milliampere Coolidge tube is used. The spark gap, however, may be adjusted according to the size of the patient.

As artifacts may easily occur as a result of incomplete distention of the bladder with opaque medium and through faulty preparation of the patient, these factors deserve special attention in the elimination of error of interpretation. It is extremely important that patients take repeated enemas prior to reporting for cystograms. In order to distend the bladder completely the cystographic medium is injected until the patient begins to feel uncomfortable and expresses a desire to urinate.

NORMAL CYSTOGRAMS

Normal cystograms are not constant in shape and size. They may be circular or oblong, pyramidal or pear-shaped, and vary from 8 centimeters in length to a size which completely fills the pelvic basin. The base usually appears just above the symphysis pubis, the greatest dimension being either in the transverse or vertical plane. The differences in the outlines of the female and male bladders were early recognized by Legueu and his associates. The characteristic of all types is the regular outline. In infants the bladder is correspondingly larger and appears higher in the pelvis.

DIVERTICULUM

Probably in no other lesion of the bladder is cystography so important as in diverticula. They may easily be overlooked in examining infected or deformed bladders although they are generally diagnosed by cystoscopic examination. Furthermore, their exact size and relation to the bladder and ureter can also be ascertained by this means. As the size of the orifice of the diverticulum is no indication of its capacity or of its ability to empty, cystography affords a means of determining the size of the diverticulum, as well as to what extent the diverticulum drains when the bladder is emptied. The nature and size of the diverticulum obviously indicates the type of treatment required. Not only is diverticulum predisposed to chronic infection because of stagnation of urine but other diseases incident to obstruction may be coexistent. Stones are found rather frequently in diverticula. When present they are usually single and may be large. They are frequently dumb-bell in shape with one end in the diverticulum and the other in the bladder. Their occurrence should be considered when the original roentgenogram shows a shadow in the bladder area suggestive of stone which cannot be identified by cystoscopic examination. Neoplasms in diverticula are comparatively rare. They may exist in a diverticulum independent of the rest of the bladder, and in such cases can be recognized in the cystogram by an irregular filling defect in the outline of the diverticulum.

Cystoscopy often reveals orifices in the wall of the bladder the exact nature of which cannot be determined by inspection alone. Prolonged obstruction in the neck of the bladder as well as atony secondary to cord lesion results in a honey-comb appearance called trabeculation. An exaggerated degree of trabeculation may give rise to cellules. Both of these conditions can be demonstrated in the outline of the cystogram. As the size of the orifice is no indication as to whether they are cellules or true diverticula, their exact nature can often be identified only by cystography. The differentiation of small diverticula is not always an easy matter. As a general rule, they are not of surgical importance and for convenience may be regarded as large cellules rather than true diverticula.

OBSTRUCTION OF THE NECK OF THE BLADDER

Cystoscopic inspection of the bladder of patients suffering from prostatic hypertrophy is often desirable though not always advisable or feasible. Cystograms in such cases may reveal conditions that modify the surgical procedure. Because of the frequent occurrence of diverticulum of the bladder with

Fig. 1.

Fig. 2.

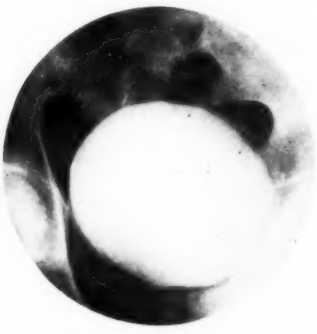

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

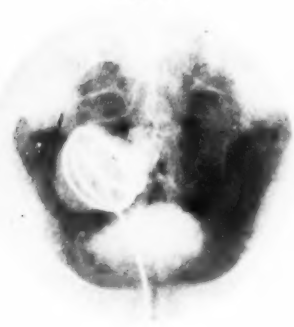

Fig. 8.

Fig. 9.

Figs. 1 and 2. Normal cystograms made at lateral angles as indicated in the technique described.

Fig. 3. Circular type of normal cystogram (lateral ray).

Fig. 4. Large type of normal cystogram in the female; the pelvic basin appears to be filled.

Fig. 5. Small pyramidal type of bladder (female). Cystogram with patient in extreme Trendelenburg position.

Fig. 6. Diverticulum in a bladder with lead catheter coiled within.

Fig. 7. Diverticulum distended with medium demonstrating capacity of diverticulum (same as Figure 6). Note that none of the medium has passed from diverticulum into bladder. The method of coiling a lead catheter in a diverticulum may be of considerable aid in demonstrating diverticula in the dome which may be difficult to outline in the cystogram if diverticulum completely empties.

Fig. 8. Lead catheter in diverticulum. Some of the medium injected into the diverticulum has escaped into the bladder. The true capacity of diverticulum, therefore, not accurately determined.

Fig. 9. Same case as Figure 8. Cystogram illustrating large capacity of diverticulum and the value of this method over that of coiling a lead catheter in the diverticulum and attempting to distend it with opaque medium.

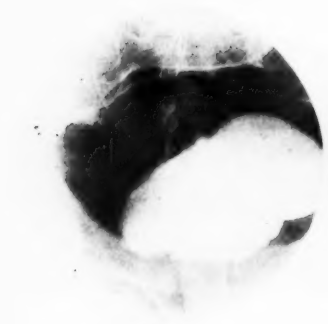

Fig. 10.

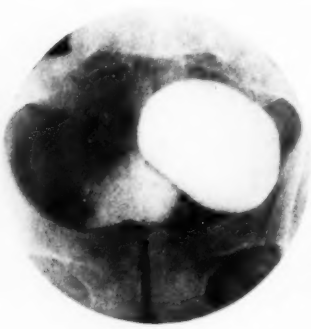

Fig. 11.

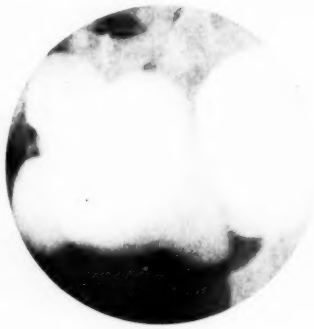

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.

Fig. 10. Irregular outline of bladder with smooth outline of diverticulum in left base.

Fig. 11. Same case as in Figure 10. Third plate after emptying bladder. Note the smooth outline of large diverticulum which does not empty. There is some residual medium in bladder which was not completely emptied by catheterization. Note that in Figure 12 the outline of the bladder partially obscures the outline of the diverticulum.

Fig. 12. Unusual outline of bladder with multiple diverticula whose combined capacity is larger than that of the bladder.

Fig. 13. Second view with bladder empty, showing three huge diverticula in left and right bases which do not empty (same case as in Figure 12).

Fig. 14. Large sacculation (sometimes termed "false diverticulum") in dome suggestive of diverticulum and definite elevation of base secondary to prostatic hypertrophy (malignant). No diverticulum demonstrated on exploration.

Fig. 15. A very distinct elevation of the base of the bladder as the result of extensive intravesical prostatic hypertrophy.

prostatic hypertrophy and the difficulty of recognition by cystoscopy we have adopted a plan whereby cystograms are made in all cases of prostatic hypertrophy before operation is considered. A study of a great many of these cystograms has led to some interesting observations. As a result of hypertrophy of the prostate a filling defect is often visible in the base of the cystogram. As this deformity, however, is not constant, different types of obstruction are probably responsible for the variation. It has been noted that hypertrophy of the prostate which is confined chiefly to the urethra may not appear in the cystogram as a deformity of the neck of the bladder. Intravesical prostatic hypertrophy in which the internal sphincter is elevated but otherwise intact may give rise to considerable deformity of the base of the bladder characterized by flattening or distinct elevation. Occasionally in an extensive intravesical prostatic enlargement when the internal sphincter is not preserved regurgitation of the medium into the urethra may occur. The resulting cystogram usually shows a distinct elevation of the trigone and a variable outline of the

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 19.

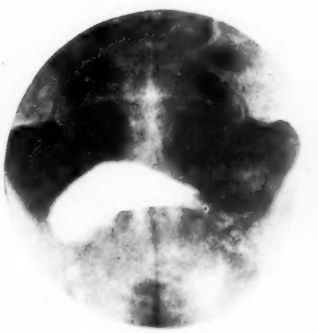

Fig. 20.

Fig. 21.

Fig. 16. Irregular cone-shaped bladder with slight elevation of base occurring with prostatic hypertrophy.

Fig. 17. Unusual type of bladder deformity occurring with prostatic hypertrophy giving rise to "cocked hat" appearance. This type of bladder may be frequently demonstrated in prostatic cases after drainage by an indwelling urethral catheter. Indentations in base probably correspond to extension of lateral lobes into bladder.

Fig. 18. Elevation of base of bladder with regurgitation of medium into posterior urethra as a result of considerable intravesical enlargement of the prostate in which the internal sphincter has not remained intact.

Fig. 19. Large indistinct filling defect in bladder base due to a huge prostate.

Fig. 20. Third view after the bladder has been emptied by catheter. The high-lying crescent shadow appearing in right base as a result of residual medium which could not be completely removed by catheter because of the large size of of the prostate, the intravesical portion of which it apparently outlines (same case as in Figure 19).

Fig. 21. Small irregular bladder with multiple cellules and reflux of medium up the right ureter secondary to prostatic hypertrophy; small diverticulum in dome indistinctly outlined.

adjacent portion of the urethra. It should be noted that apparent deformity in the base of the bladder in the cystogram is but presumptive evidence of prostatic hypertrophy. Additional data are required for a positive diagnosis.

The size of the prostate is not commensurate with the degree of elevation. It has been noted that extensive prostatic hypertrophy may cause but little elevation in the base of the cystogram, and vice versa. Elevation of the base of the bladder is occasionally noted with spasm without prostatic hypertrophy. Aside from the crescent deformity in the base various irregularities may be noted, any one or all of which may be concomitant with the elevation of the base. They are: (1) irregularity of the outline of the bladder as a result of trabeculation and cellules, (2) diverticula, (3) regurgitation of medium into one or both ureters, and (4) localized sacculation.

Sacculation of the wall of the bladder may produce a distorted outline in the cystogram suggestive of diverticulum. Sacculations prob-

Fig. 22.

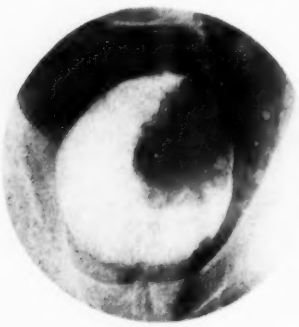

Fig. 23.

Fig. 24.

Fig. 25.

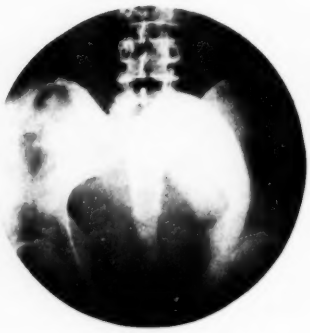

Fig. 26.

Fig. 29.

Fig. 22. Irregular filling defect in left base wall and dome was a result of neoplasm. Operation revealed inoperable carcinoma involving approximately half of the bladder.

Fig. 23. Extensive carcinoma of the bladder with irregular filling defect in left wall and dome. Exploration showed about one-third of bladder to be involved.

Fig. 24. Extensive filling defect of base and dome as the result of extensive carcinoma (inoperable).

Fig. 25. Irregular filling defect of base as a result of extensive carcinoma of the internal sphincter and bladder base.

Fig. 26. Unusual position of bladder with marked deformity as a result of displacement and pressure from a large cyst originating either from the prostate or seminal vesicles.

Fig. 29. Irregular cone-shaped bladder with regurgitation of medium into posterior urethra as a result of relaxation of internal sphincter secondary to cord lesions.

ably result from areas of bulging in the wall of atonic bladders and should be borne in mind in the differential diagnosis of true diverticula. It has been noted that when deformity of the bladder occurs as the result of an apparent pouching of its wall the outline of the cystogram is regular. This is in contradistinction to the irregular outline of the bladder so common with diverticula. Sacculations or false diverticula always completely empty themselves.

Carcinoma of the prostate does not cause any typical deformity in the bladder outline. As a rule the elevation of the base of the bladder is more diffuse, flatter, and not so marked as with adenoma. Filling defects in the base or wall of the bladder as a result of secondary involvement may occasionally occur.

DEFORMITY FROM NEOPLASM

It may be impossible to make a satisfactory cystoscopic examination in the presence of a tumor in the bladder because of profuse hæmorrhage, intolerance, vesical contraction, or deformity. In such cases a cystogram may reveal the extent and situation of the neoplasm and aid in determining the proper treatment generally. Generally when the filling defect is extensive and involves most of the bladder outline, it may be regarded as in-

Fig. 27. Value of cystography in a case of persistent pyuria in a female child of 8 years. Note small irregular bladder with regurgitation of medium up both ureters and pelvis. Bilateral hydronephrosis and hydro-ureter as the result of congenital atony of the urinary tract.

Fig. 28. Bilateral hydro-ureter and hydronephrosis in case of man, aged 21, with marked urinary infection.

operable, although a large pedunculated tumor, particularly of the benign type, may cause an immense filling defect, giving a false impression of an inoperable tumor. The outline of a bladder containing a neoplasm is characterized by an irregular filling defect at the site of the tumor. The extent and situation of the filling defect will vary with the thickness and size of the tumor. Occasionally the tumor is more extensive than the deformity would indicate. It should be noted that in some cases of hæmorrhage blood clots in the bladder may produce filling defects in the cystogram which may simulate the deformity caused by tumor. The site and extent of tumors involving the sphincter may be difficult to determine by means of cystoscopy. These can often be more accurately ascertained by cystography.

INFLAMMATION

Prolonged inflammation of the bladder, such as occurs secondary to pyelonephritis or renal tuberculosis, may cause marked deformity of the bladder outline. The cystogram appears small, contracted and irregular, and often cone-shaped. A similar deformity may be seen in a cystogram made of a bladder which is being continuously drained by an indwelling catheter. As a result of coincident inflammatory changes in the lower part of the ureter, regurgitation of the medium up one or both ureters may be demonstrated.

EXTRAVESICAL PRESSURE

Pressure on the bladder from adjacent structures may be demonstrated in the cystogram. Cystography may also occasionally be of some aid in the recognition of extravesical lesions. Elevation of the base of the bladder by hypertrophy of the prostate has been described. Tumors of the cervix may cause a similar deformity. With tumor of the body of the uterus, there may be a distinct cleft in the outline of the dome of the bladder as the result of pressure. The deformity may cause a filling defect similar to that produced by neoplasm. As a rule, however, the latter is differentiated by greater irregularity of the filling defect. Cysts

Fig. 30. Cystogram of cord bladder occurring in a young boy following an attempt to repair a spina bifida. Note irregular outline of bladder resulting from cellules and trabeculation and reflux of medium up both ureters, demonstrating bilateral hydro-ureter and hydronephrosis. The internal sphincter is relaxed. Some medium may be seen in the bulbous portion of the posterior urethra.

arising from the prostate or seminal vesicle may cause rather marked displacement and deformity of the bladder outline. Similar displacement may result from perivesical abscess. The deformity simulates that of bladder neoplasm but is not as a rule as irregular as that occurring with vesical neoplasm. In huge inguinal hernias, if the scrotal contents are uncertain, a cystogram may be of value in excluding or demonstrating hernia of the bladder.

REGURGITATION OR REFLUX

The passage of fluid from the bladder into the ureters can be demonstrated by means of cystography. Graves and Davidoff, in numerous experiments, sought to explain the phenomenon of the regurgitation of vesical contents. It is probable that in normal persons the mechanism of the ureterovesical juncture is so regulated that the bladder contents do not flow back into the ureter. Under pathological changes, both local and general, this mechanism is altered and permits communication between the bladder and renal pelvis. This is illustrated in cases of patulous ureters resulting from chronic pyogenic and tuberculous infections of the urinary tract. In lesions of the spinal cord as a result of disease or injury a similar occurrence takes place because of atony. Bladder contents occasionally gain entrance to the ureter as a result of obstruction in the region of the vesical neck. Graves and O'Conner distinguish between the terms "regurgitation" and "reflux." Regurgitation denotes the passage of bladder contents into the ureter or kidney when the bladder and ureteral muscle-tone is obviously normal. To the passage of medium into the ureter by direct continuity due to loss of bladder and ureteral muscle-tone as a result of the obstruction of the neck of the bladder and from disease of the spinal cord they give the term reflux. At present the terms reflux and regurgitation are used rather interchangeably, either term indicating a continuous communication between bladder and ureter regardless of the etiological factor. Because of the frequent occurrence of ureterectasis with infection and pyelectasis with regurgitation of vesical contents in infants, a cystogram is of considerable importance in determining the actual condition of the urinary tract. It is indicated in all cases of persistent pyuria in infants not controlled by medical measures.

CORD BLADDER

Disease or injury of the spinal cord frequently results in lesions of the bladder requiring the aid of the urologist. Occasionally the lesion may be the first manifestation of the disease, and cystoscopy may give the first clue to the disorder. Cystography is often of aid in establishing the diagnosis. The changes in the cystogram incident to the disease are consistent, and are characterized by the outline of a large irregular bladder, relaxation of the internal sphincter, as indicated by regurgitation of medium into the posterior urethra, and frequently by regurgitation of medium up one or both ureters. On account of relaxation of the internal sphincter and regurgitation into the posterior urethra there is frequently a

triangular-shaped extension from the median base of the bladder outline into the urethra for a distance of 1 to 2 centimeters with its apex in the urethra (Figs. 1 to 30).

SUMMARY

Cystography is not intended to replace ocular inspection of the bladder but to corroborate cystoscopic findings. It may be of considerable value in ascertaining the presence of bladder lesions when the general condition of the patient or technical difficulties preclude cystoscopy. Cystography affords a means whereby diverticulum of the bladder is recognized and also furnishes information as to the capacity and ability of the bladder to empty.

In cases of vesical neoplasm cystography may portray the site and extent of the malignancy and determine the advisability of operative procedure.

Lesions of the bladder secondary to cord changes may be recognized by characteristic variations in outline together with evidence of regurgitation of medium into the ureter and urethra. Various deformities of the bladder occurring with hypertrophy of the prostate have been noted.

The importance of cystography in infants with persistent pyuria is emphasized because of its value in determining the presence of atony of the urinary tract with resultant ureterectasis and pyelectasis. Deformity of the bladder from extravesical pressure may be recognized in the cystogram, the outline of which is usually regular in contrast to the more irregular filling defect caused by neoplasm.

A satisfactory technique for making cystograms is described.

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Fig. 3. Division of the duodenum.

Partial Gastrectomy for Gastric Ulcer.—Digby Chamberlain.

CLINICAL SURGERY

FROM THE CLINIC OF SIR BERKELEY MOYNIHAN

PARTIAL GASTRECTOMY FOR GASTRIC ULCER

By DIGBY CHAMBERLAIN, CH.M., F.R.C.S., LEEDS, ENGLAND
The General Infirmary at Leeds

WHEN the question of the desirability of performing a partial resection of the stomach for ulcer is being considered, if we regard it from the purely statistical point of view completely ignoring the greater comfort and the more certain relief of symptoms which follow this operation, we find that it is unquestionably the treatment of election. The dangers of perforation of the ulcer or hæmorrhage from one of its supplying vessels may be disregarded, as they can be minimized, if not completely overcome, by almost all the other operations which have been described. The complication of malignant disease, which can be dealt with effectively only by this operation provides figures which are a certain guide. The incidence of carcinoma in neglected ulcers of the stomach has been variously estimated, but if we accept the conservative figure of 9.5 per cent, which is the outcome of a detailed examination of 216 consecutive cases at Leeds, we see that one person out of every ten who has a gastric ulcer is doomed to die from carcinoma of the stomach. The mortality for partial gastrectomy as I am about to describe it has been about 3 per cent during the last 10 years, so that the non-operative mortality is three times as great as the operative. An operative mortality of this size can be attained only by the utmost attention to detail during the operation and careful pre-operative and post-operative treatment.

COMPLICATIONS

Reports have been made from time to time of leakage from the suture line, in most cases from the cut end of the duodenum, with the production of a general peritonitis. In one case, where a cholecystectomy had been performed at the same time, I have seen an obstruction to the transverse colon by the pre-anastomotic part of the jejunum, the postanastomotic part having become adherent to the gall-bladder fossa. Anastomotic ulcers have been reported in rare cases, but if the operation is regarded merely as an incident in the treatment of gastric ulcer and not as a panacea for the future, this complication is not likely to be encountered. It may be that postoperative bleeding from the suture line is a potent causative factor, as the raw area, which must be left exposed to the action of the gastric secretions, may be the starting point of an ulcer which may not call attention to itself for weeks or months. Actually we have never had a case of anastomotic ulcer following partial gastrectomy for gastric ulcer; the only cases which have occurred here have been after resection of the stomach for ulceration at the site of a previous gastro-enterostomy opening

PRE-OPERATIVE TREATMENT

It has been the custom to keep the patient in hospital for a week or 10 days before operation, so that he may become accustomed to his new surroundings and have a complete radiological and chemical investigation done. During this time any focus of infection which may be present is dealt with, particular attention being directed to the mouth where carious teeth are extracted and any septic cavities are rendered aseptic and filled.

As many of these patients are anæmic and somewhat emaciated, blood transfusion on one or more occasions, according to the general condition, is employed. A 5 per cent solution of glucose is given by the rectum or by the mouth if it can be tolerated, until 15 or 20 pints have been absorbed. Sugar may appear in the urine, so that the presence of diabetes is to be eliminated before the administration of glucose is begun. In some cases the patient is sent to a convalescent home or to the seaside for 2 or 3 weeks before the operation is undertaken. Artificial sunlight

Fig. 1. Flat swabs being put into position to hold the stomach over to the right.

baths have also been used pre-operatively in many cases.

While in hospital he is kept on a light but nutritious diet until the evening before operation, when a purge of castor oil is given, to be followed by an enema on the following morning. Stomach washes are not used, except in the occasional case in which there is complete retention and putrefaction is going on, as they usually upset the patient considerably. The skin is prepared for operation over an area extending from the nipples to the thighs, a 3 per cent solution of picric acid in spirit being used as a final application, after which a sterile sheet is fastened round the patient. Finally, before leaving the ward for the operating theater, the patient is given an injection of morphia 1/6 grain, and scopolamine 1/200 grain.

THE ANÆSTHETIC

Anæsthesia is produced by gas and oxygen administered through a Boyle's apparatus. A little ether is added while the abdomen is being opened and closed but the amount used rarely exceeds 1 to 2 ounces. In cases in which there is some degree of bronchitis, atropine, 1/100 grain has been found to be advantageous and may be substituted for scopolamine in the preliminary injection.

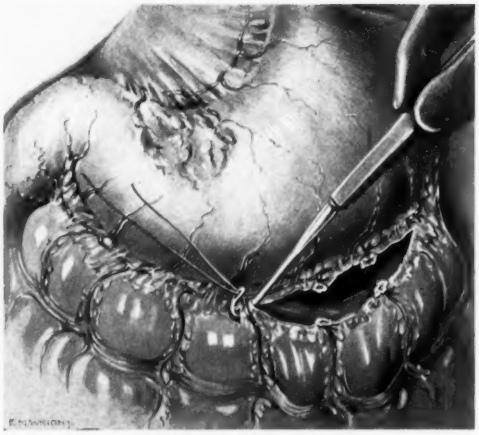

Fig. 2. Great omentum being detached from the greater curvature of the stomach.

THE OPERATION

The abdominal wall is prepared as in the pre-operative preparation except that the final application is Harrington's solution in this case. The sheets are then adjusted. It has been found less trying to the eyes of the operator if the sheets are green. A red square is put on the instrument tray at the foot of the patient, on which soiled instruments may be placed. Once an instrument is on the red square it is not touched except to be taken away and resterilized.

The abdomen is opened by a paramedian incision, extending from the costal margin to just below the umbilicus, the rectus muscle being displaced outward. Every bleeding point is clipped with artery forceps and ligatured with fine catgut, before the peritoneum is incised; some of the muscular branches may retract into the rectus and can be controlled only by a stitch. As soon as the rectus sheath is reached, tetra cloths are applied to the edges of the wound, gripping the tetra, the sheet, and between them the skin so that the skin is not punctured. The tetra is folded back over the forceps, which are thus hidden and prevented from getting entangled with ligatures during the subsequent course of the operation. The peritoneum is then picked up and opened.

We examine the stomach visually and by palpation, starting at the œsophageal opening and working along the lesser curvature. The rest of the abdominal viscera are palpated to exclude coexisting disease, and the cæcum is delivered out

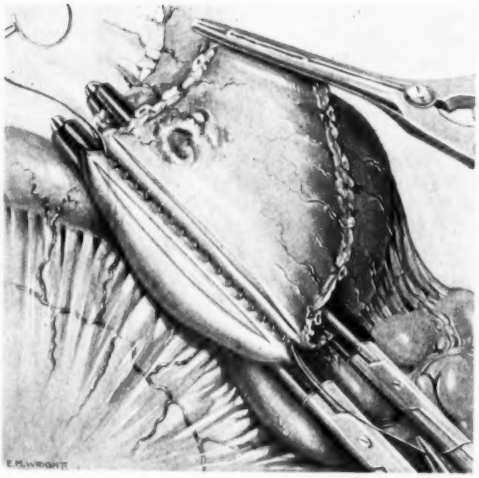

Fig. 4. Serous stitch inserted. Stomach ready for removal.

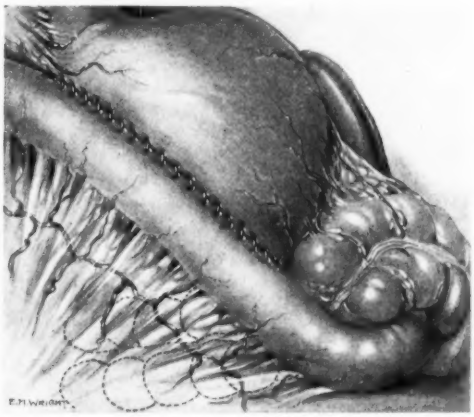

Fig. 5. Operation complete. Note the close relation of the jejunum to the splenic flexure of the colon.

of the lower end of the wound and the appendix is crushed and removed.

To make the stomach more accessible and to prevent it from retracting after it has been divided, a large flat swab is packed into the abdomen in the following way. The stomach is drawn out of the wound to the right as far as possible, the left side of the abdominal incision is held up by an assistant, and the flat swab is packed down between the two so as to hold the stomach over to the right (Fig. 1).

A piece of the lesser omentum above the first part of the duodenum is selected and divided between ligatures. A finger is passed through this opening, behind the duodenum to the great omentum, where an avascular space is opened out and a clip passed through it on to the tip of the finger. The clip is passed deep to the duodenum and through the opening in the lesser omentum, keeping in contact with the finger the whole time. One blade of a Payr clamp is seized by the clip which is then drawn through behind the duodenum, when the clamp can be tightened. A second Payr clamp is passed close to the first one and the duodenum divided between the two. The cut ends are sterilized by applying to them pure carbolic acid or heat from the actual cautery.

As a modification of this the following plan has been adopted recently. A start is made by picking up a piece of the great omentum about the middle of the greater curvature and dividing it between ligatures (Fig. 2). This division is carried along to the right to the duodenum and then a piece of the lesser omentum at the upper border of the duodenum is similarly divided between ligatures. Clamps can be applied and the duodenum divided as already described (Fig. 3). By approaching the duodenum in this way, we obtain much freer access, and the blade of the clamp which lies deep to the duodenum, can be passed under direct vision.

The great omentum is next detached from the greater curvature of the stomach. It is punctured by an aneurism needle guided by the finger, a double ligature is drawn through, tied, and the omentum is divided between the ligatures. This division is carried up beyond the ulcer and the lesser curvature is similarly dealt with, great care being taken to ligate the coronary artery securely. When this vessel, which acts as an anchor, is divided, the stomach can be delivered more completely from its bed.

At this stage, the cut end of the duodenum is closed. A continuous thread suture is put into the duodenum over the Payr clamp, which is then withdrawn and the crushed end invaginated. The stitch is carried back to the starting point and tied. It is usually possible to bury this closed end in the peritoneum covering the anterior surface of the pancreas.

A clamp is now applied to the stomach above the ulcer, and the first loop of the jejunum is identified. This is brought straight from the duodenojejunal flexure across the transverse colon close to the splenic flexure and directed across the abdomen from left to right parallel to the stomach clamp and a clamp is applied to it.

The distance from the duodenojejunal flexure to the proximal part of the anastomosis is about 4 inches. Everything except the stomach and this small piece of the jejunum should be inside the abdomen and protected by mackintosh cloths. It is a rule to which there is no exception that only that part of the gastro-intestinal tract which is being operated on should be visible, and by adhering to this rule loss of heat and moisture from the viscera, and therefore shock, are reduced to a minimum.

All suturing is done with chromicized catgut, its size being ooooooo. It is used in an intestinal needle curved to an arc of 5/8 of a circle and having a spring eye. Starting at the greater curvature, we insert a continuous stitch to join the peritoneum on the opposed sides of the stomach and jejunum (Fig. 4).

The stomach is held up by the assistant and a cut is made through the serous and muscular coats on both sides ½ inch or ¾ inch from the clamp. This incision must be well away from the clamp, particularly on the anterior surface of the stomach, as the cut end of the stomach tends to retract into the clamp. A second clamp is applied to the stomach close to and distal to the first one, and before being completely closed is worked along to lie just distal to the seromuscular incision, in such a way that it empties the lumen, between the clamps, of its contents. The mucous membrane is next divided with scissors along the line of the seromuscular cut, any contents of the stomach which are present being mopped up, and the stomach is removed.

An incision is made into the peritoneum of the jejunum equal in length to the cut end of the stomach; and the mucous membrane, oval in shape, which bulges through this cut, is removed with the scissors. Again starting at the greater curvature, we insert a continuous catgut suture, taking up the mucous membrane and muscle, right round the circumference of the stomach. This suture is simply a running stitch except at the ends where one or two Connell stitches are employed to turn the corner. It is better that the mucous membrane should show between the stitches, as hæmostasis is thereby insured. This stitch is then tied off at its starting point. In order to facilitate the insertion of this stitch the following plan has been adopted. The assistant holds a closed pair of artery forceps in his right hand and a thread holder in his left hand; with this latter he grasps the stitch as soon as it has been drawn tight, while the forceps are held on the suture line immediately behind the stitch which is being inserted in order to guide it accurately into position. In this way the stitch, as it is being drawn tight, is prevented from picking up a piece of mucous membrane at a distance. This plan is used only while the posterior layer of stitches is being inserted. When the anterior surface of the stomach is being stitched to the jejunum, it is essential that the needle should not pick up the posterior suture line, and to prevent this the flat blade of a pair of scissors is laid on this suture line and held by the assistant in such a way as to protect it. Four or five retracting stitches are put into the suture line before the clamps are removed, as otherwise the stomach tends to retract to a place where it is not accessible. The clamps are then removed, all swabs which have been used thrown away, and gloves, which may have become infected from the mucous membrane, changed.

The peritoneal stitch is picked up and run from the lesser to the greater curvature of the stomach, where it is tied off to its commencement. It will be found that large vessels at the two curvatures course toward the suture line, and it is better to make certain that they are occluded by underrunning them with a stitch. The suture line is inspected and, if necessary, reinforced at one or two places by an additional stitch. The retracting stitches are cut out and the flat swab which was put up against the spleen at the beginning of the operation is taken out, when it will be found that the stomach retracts almost out of sight under the ribs (Fig. 5). Finally, before the abdomen is closed, the great omentum is folded up in such a way that it covers the suture line and prevents it from adhering to the anterior abdominal wall.

In some cases the operation is complicated by the fact that the ulcer is adherent to surrounding structures, frequently the pancreas, when it must be separated from that organ with a scalpel. No danger is to be feared from leaving this raw area of pancreas, as it is fibrosed and pancreatic juice will not escape from it, but to prevent adhesions, it is better, if possible, to cover it over with a neighbouring piece of peritoneum or fat. Before the abdomen is closed, about half a pint of normal saline solution may be left in the peritoneal cavity from which the solution will be rapidly absorbed.

The abdomen is closed in layers, a continuous catgut stitch being used for the peritoneum, interrupted catgut stitches for the anterior sheath of the rectus, and silkworm-gut sutures through the skin, superficial fat, and the anterior sheath of the rectus. When the tetra cloths are removed, that is, when the peritoneum has been closed,

the skin should be recleaned with pink spirit. Finally, the skin edges are approximated by means of Michel clips and a sterile dressing is applied.

In order to save time, two theaters are used, an assistant opening and closing the abdomen in one, while the surgeon carries out the intra-abdominal part of the operation in the other. The surgeon does not leave a case until the peritoneum is closed, so that there can be no chance of a swab being left behind.

The patient is wheeled back to the ward, and as soon as the effects of the anæsthetic have passed off, he is put up into Fowler's position. Glucose is administered by continuous rectal infusion and in bad cases a further transfusion of blood is given.

Feeding is commenced on the following day by giving small frequent sterile drinks, which are gradually increased in amount. Milk pudding is given on the seventh day and chicken on the tenth. The patients are allowed to get up after 3 weeks, but should be warned that for a time at least, it is essential that they should exercise a certain amount of care in their diet. On leaving the hospital they are given a chart suggesting, on broad lines, what should be taken. In addition, smoking is forbidden and alkalis are taken before meals for 6 months.

As to the efficacy of the operation, I cannot do better than to quote a patient whom I saw recently, 2 years after his stomach had been removed, and who, on being questioned, said that he felt as if he could digest a brick.

FROM THE SURGICAL CLINIC OF GUY'S HOSPITAL

CHOLECYSTECTOMY

By R. P. ROWLANDS, O.B.E., M.S. (Lond.), F.R.C.S. (Eng.), London, England
Surgeon to Guy's Hospital

INDICATIONS FOR OPERATION

THE chief indications for cholecystectomy are irreparable wounds and injuries or diseases of the gall bladder and its ducts, in cases in which the common bile duct is healthy and patent. The following are the most important of these diseases: Acute, chronic and recurrent cholecystitis, especially when associated with gall stones; gangrene; perforation, with or without cholelithiasis; empyema, hydrops, or mucous fistula of the gall bladder due to obstruction of the cystic duct by stone, kink, or stricture; papilloma or carcinoma of the gall bladder; volvulus of the gall bladder; and biliary fistula or chronic jaundice due to kinking of the common bile duct following cholecystostomy.

It is not wise, especially for a surgeon without special experience, to undertake this operation when the patient is very ill, old, or feeble; or when the mechanical difficulties of the operation are great. Cholecystostomy is safer under such circumstances. Secondary cholecystectomy can be performed under more favorable circumstances if the symptoms recur. Neither should cholecystectomy be attempted when there is jaundice of some weeks' duration with consequent risk of hæmorrhage, unless the normal coagulation time has been restored by treatment; nor when there is cholangitis. Cholecystectomy should never be performed unless it is certain that the common bile duct is patent.

DANGERS AND POSSIBLE COMPLICATIONS

An accurate knowledge of the normal and abnormal anatomy of the biliary apparatus is essential to all surgeons who undertake operations on these intricate parts (Fig. 1). E. R. Flint (1) has drawn attention to abnormalities of the bile ducts and associated blood vessels and has rightly laid stress upon their surgical significance. The arrangements of the vessels and ducts given as normal in the textbooks was found in only 69 out of 200 consecutive dissections. Lack of knowledge of abnormalities and want of care in exposing the ducts may lead to severe hæmorrhage or to grave injuries of the ducts during the operation of cholecystectomy. The occasional presence of the right hepatic or cystic artery in front instead of behind or to the left of the common hepatic or common bile duct may lead to trouble. An accessory right hepatic duct, which is present in about one-seventh of the cases, is very liable to be divided and, if this accident is not recognized, the escape of bile into the peritoneum may lead to death, especially if the abdomen has been closed without drainage.

Abnormalities of the cystic duct have often led to error. This duct may be absent (Walton, 3), unduly short, or abnormally inserted into the common bile duct, behind or on the left side of the latter; it commonly runs parallel to the common bile duct and is adherent to it for some distance before actually opening into it. In about one-seventh of Flint's dissections, the cystic duct opened into the retroduodenal part of the bile duct, so that there was no common bile duct above the duodenum.

The pelvis of the gall bladder often enlarges and extends in front or behind the common bile duct, to which it may be intimately adherent, so that the latter may be mistaken for the cystic duct and divided.

PREPARATION OF THE PATIENT

Except in urgent cases, the patient is kept at rest and prepared for 2 days before the operation. An aperient is given not later than 24 hours, followed if necessary by an enema not later than 8 hours, before the operation. The mouth is carefully cleansed and, if necessary, the operation is deferred until all signs of oral sepsis have been eliminated. It is particularly important to do so if there is any indication of recent acute septic infection of the nose or throat, on account of the danger of pneumonia supervening. If the clotting time of the blood is above normal because of obstructive jaundice, I inject intravenously 5 cubic centimeters of a 10 per cent sterile solution of calcium chloride (2), once a day for 2 or 3 days before the operation. If there is any indication of deficiency of the liver function, carbohydrates and water are freely administered by the mouth and a 5 per cent solution of glucose is given by the rectum.

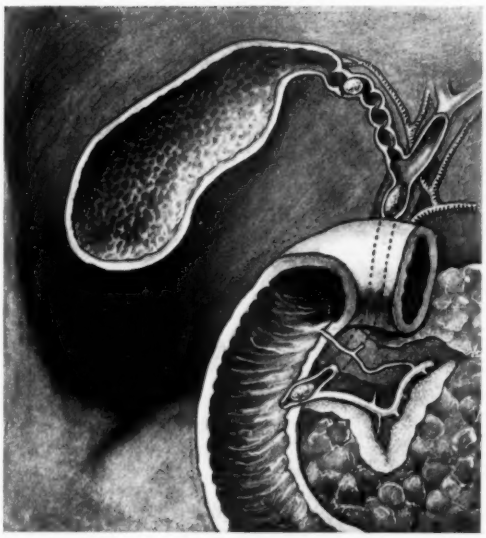

Fig. 1. Anatomy of the biliary apparatus. Stones are shown in the cystic duct, common bile duct, and ampulla of Vater. The pancreatic duct of Wirsung and the accessory duct of Santorini are shown, the latter opening separately into the duodenum.

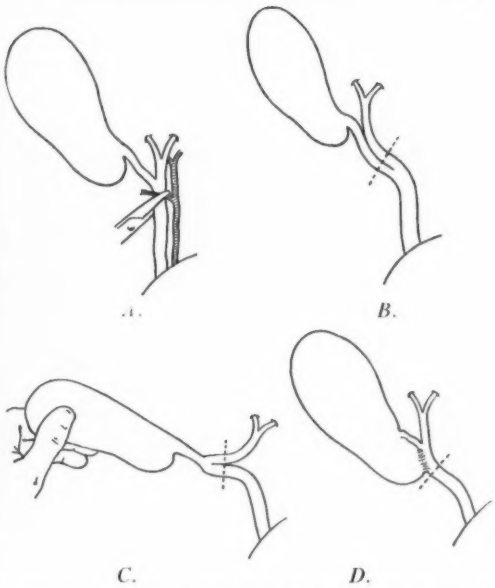

Fig. 2. *A*. Common bile duct clamped, with abnormal cystic artery. *B*. Division of common hepatic duct with parallel adherent cystic duct. *C*. Traction causing dangerous looping of common bile duct. *D*. Hartmann pouch or pelvis of full gall bladder adherent to the common duct. (After A. J. Walton.)

Fig. 3. Kocher's incision, *K*. All the fibers of the right rectus, but no important nerves, are divided, although the incision may be prolonged across the linea alba and outward into the external oblique muscle.

The day before the operation the skin of the abdomen is shaved, a warm bath is given and, later, the abdomen is painted with tincture of iodine; no compress is applied. The skin is again painted with iodine when the patient is on the operating table.

OPERATION

In order to render the parts more accessible, the bridge or cushion is raised under the patient's back at the level of the liver. This brings the common duct two or three inches nearer to the surface, and also tends to open out the costal angle and displace the intestines downward away from the liver. The patient's head is raised and his thighs somewhat flexed to relax the recti.

I believe that Kocher's incision is the best for this operation (Fig. 3). It starts just below the tip of the ensiform cartilage and runs obliquely downward and to the right, 1½ inches below the costal margin. It descends a little toward its outer end and completely divides both the muscular fibers and the fibrous sheath of the right rectus muscle. Cutting across the rectus sheath gives far better access than vertical slitting. If necessary the incision may be prolonged slightly into the muscular fibers of the external oblique without dividing any of the intercostal nerves. This gives a direct and wonderful view, almost abolishes the need of retractors, and the lower edge of the incision keeps the intestines from prolapsing. Hernia is very rare after this incision, even when drainage has to be adopted (Fig. 4).

Every bleeding vessel is immediately tied with fine catgut and the transversalis and peritoneum are incised freely. The falciform ligament is also clamped and divided if necessary. The abdomen is rapidly explored unless there is some contraindication, and the whole biliary apparatus is always carefully examined, for it is vital to determine if the common bile duct is normal, to see if its

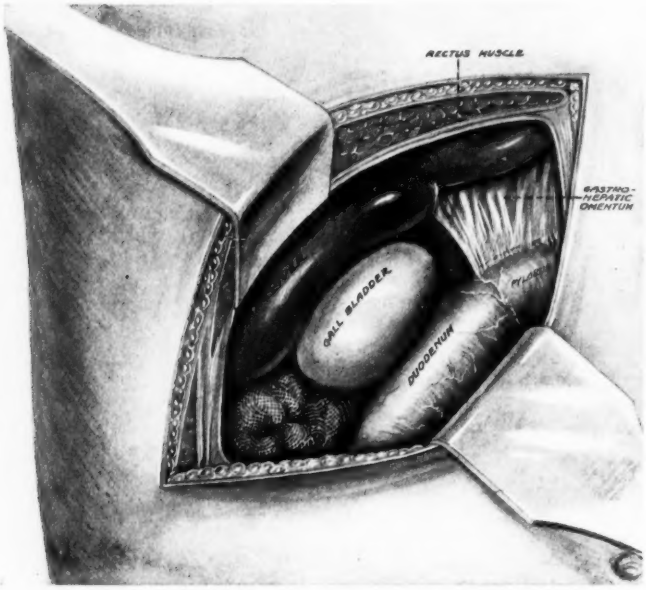

Fig. 4. Kocher's oblique incision across the rectus abdominis.

first part, above the duodenum, is dilated or not, and to palpate its second and third parts, the head of the pancreas and the duodenal papilla for stone, induration, or growth.

If the disease is limited to the gall bladder and removal of the gall bladder is considered necessary after due deliberation, the liver is displaced downward and rotated, if possible. A gauze pack is placed above and behind it, if necessary, to retain it in this advantageous position. A dry gauze roll is carefully packed into the right kidney pouch and a large aseptic pad, with tape attached, is fixed at the inner part of the wound to protect the stomach and duodenum. When the gall bladder has been carefully freed from adhesions to the omentum, colon, or duodenum, its fundus (and often its dilated, prolapsed pelvis also) is seized with forceps and drawn forward by an assistant, while the surgeon exposes the cystic duct by incising the peritoneal fold extending from the gall bladder to the front margin of the foramen of Winslow. When the gall bladder is large, distended, and folded downward awkwardly at the neck, it is first emptied with a trocar and cannula, and the opening is carefully closed by clamping.

Careful blunt dissection soon displays the duct and, to avoid any chance of error, the duct must be followed from the gall bladder to its junction with the common bile and common hepatic ducts, which must be clearly displayed. For this, patience and a good light are essential. When the cystic duct has been carefully dissected out of its bed, it is tied with catgut, about a quarter of an inch from its termination, and divided between the ligature and a firm, long handled, curved clamp which prevents leaking from the gall bladder and is useful for gentle traction. The cystic artery and vein are similarly isolated, tied and divided as they pass forward usually between the cystic duct and the liver. The greatest care is necessary to avoid clamping or wounding the common hepatic duct, its right tributary, or an accessory right hepatic duct. It is all too easy to injure these, particularly if the gall bladder is distended or folded at its neck and the connective tissues in the portal fissure inflamed, œdematous, or indurated. This danger is increased if the cystic artery is not well secured but is carelessly divided and allowed to retract and bleed in the depth of the wound (Figs. 2 and 5).

The gall bladder is now separated from the liver from behind forward, by blunt dissection with the finger. The peritoneal covering is saved, as far as possible, until the separation is nearly completed. It is then so divided with scissors that

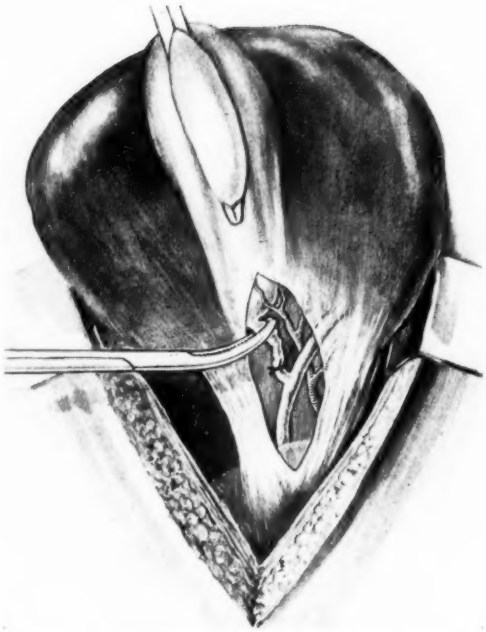

Fig. 5. Cholecystectomy. The cystic duct has been tied and clamped. The gall bladder is held up with forceps.

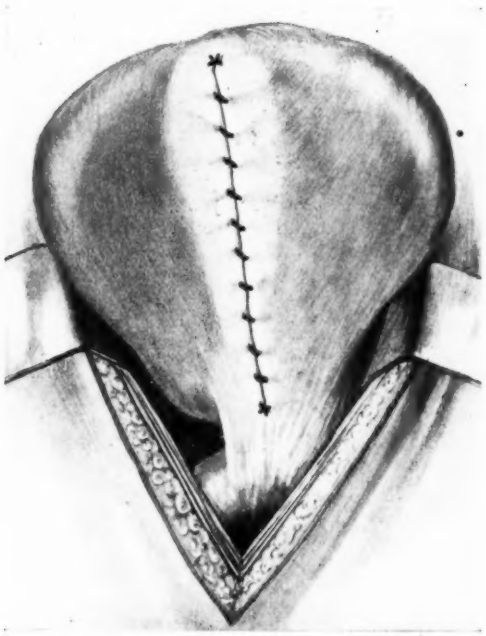

Fig. 6. Cholecystectomy. The operation completed by suture of the peritoneum over the raw surface of the liver.

the edges can be sewn together to cover the raw surface of the liver. This arrests hæmorrhage from the liver and minimizes adhesions. Occasionally, when there are very dense adhesions about the neck of the gall bladder, it may be safer to separate it from before backward, but as a rule this is more tedious and causes more bleeding. Rarely it is safer to open the bladder along its inferior surface and to trace its mucous membrane back to the cystic duct.

The stump of the cystic duct is buried and the raw surface of the liver covered by sewing flaps of the peritoneum over them (Fig. 6). Unless all oozing has been stopped, it is wise to drain the wound at its outer angle with a small short, soft rubber tube for 36 hours.

The bridge is let down and the parietal wound is accurately closed in layers as follows:

A continuous suture of No. 2 formalized catgut is begun at the inner angle of the wound and, picking up the peritoneum, aponeurosis and the deeper half of the rectus muscle, it is continued to the outer angle of the wound; then, picking up the anterior aponeurosis and the anterior fibers of the rectus, it is carried back to the inner end of the wound and tied there. Three or four mattress supporting sutures of No. 2 catgut are then placed in the rectus sheath and muscle. The skin is closed with a continuous suture of fine linen thread. The rubber tube is sewn to the skin at the outer angle of the wound.

AFTER-TREATMENT

If all goes well, the drainage tube is removed at the end of 36 hours. As a rule the wound needs no further attention until the stitches are removed at the end of a week. The patient is encouraged to move about in bed from the beginning, often sitting up during the day, in an oblique position, and lying down at night, on one side or the other: change of position and movements are insisted upon, as are breathing exercises. Especial care is taken to see that the bandages are never tight across the lower part of the chest. As a rule the patient is allowed out of bed, and to stand and walk a little, on the fourth or fifth day and is generally able to leave the Hospital or Nursing Home after 2 or 3 weeks. He is advised to take a holiday of a month or six weeks, with gradually increasing exercise, at the end of which time he should be fit to return to work and his normal mode of life.

Gentle exercise (especially movements of the trunk in all directions), are encouraged from the beginning with the idea of preventing stiffness from adhesions in the right flank. Occasionally adhesions cause trouble by engaging the duodenum or pylorus, thus causing partial pyloric obstruction, but much can be done to avoid this complication by carefully covering the defect on the under surface of the liver by sewing the peritoneum, as indicated in Figure 6, or by using flaps of great omentum to cover this area.

Patients do remarkably well after cholecystectomy and are peculiarly free from the recurrence of symptoms which so commonly follows cholecystostomy. The mortality of the operation is from 1 to 2 per cent.

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PLASTIC RECONSTRUCTION OF THE AXILLA IN THE OPERATION FOR CANCER OF THE BREAST

Report of the Author's First Fifty Cases[1]

By WILLIAM T. COUGHLIN, M.D., St. Louis, Missouri

THE greatest advance that has been made in the treatment of cancer of the breast is due to William S. Halsted. We might contrast the prognosis of breast cancer surgery before and since his publication of 1894 just as is sometimes done of surgery before and since Pasteur.

In pre-Halsted days recurrence of the cancer was the rule, now it is rather the exception. "The younger Gross did not save one in his first hundred cases, Sands had never saved one, and Agnew believed that the operation always shortened life." Velpeau had recorded 170 cases and only 7 of them lived more than 5 years. Billroth acknowledged 85 per cent recurrence, Bergman 51 per cent, and the results of all of the other celebrated German surgeons lay somewhere between these figures.

Now by recurrence is meant return of the carcinoma in the scar or in the field of operation. Billroth thought that if no nodule could be palpated at the end of a year the case was cured, but Volkmann thought that none should be pronounced cured until after 3 years' freedom from recurrence. I wonder how many of those who read this would be willing to pronounce *any* of his former patients cured! that is, certain never to die as a consequence of that cancer long since removed.

Volkmann advised the removal of the axillary glands when these were palpably involved but to Kuester belongs the credit of being the first to advocate their removal in all cases—whether they were palpably involved or not. Kuester also had removed both pectorals in the worst cases (38 with 13 recurrences). He advised going wide of the cancer, and he advocated removal of the fascia covering the pectoral muscles in all cases—he had found cancer cells spreading out over the surface (a lymph-space?) and infiltrating the fascia and even the muscle.

The name of Heidenhain is one that we should respect as much as, if not more than that of Halsted, Volkmann, or Kuester.

Working in Kuester's clinic Heidenhain was struck by the extraordinary frequency of recurrence after operations for cancer of the breast. Investigating he found that the poor results were not confined to the clinic of Kuester. The published results gave the combined average for the German surgeons as "freedom from recurrence after 3 years only 17.2 per cent."

Heidenhain was the first to insist that recurrence meant inefficient operation. He made a microscopic study of sections from the cut surfaces of 18 breasts removed by Kuester and was able correctly to forecast recurrence before this took place, in those cases in which the cut edge showed cancer infiltration.

Halsted insisted that recurrence in the scar must be the result of poor surgery although no one could be blamed if recurrence took place in the skin nearby. Willy Meyer published his method very shortly after that of Halsted appeared. He advocated the removal of both *pectoral muscles*, and gave credit for the idea to Gerster (1885). Halsted advocated the removal of the sternal part of the pectoralis major, working from within outward and doing the axilla last. Meyer advised first cleaning out the axilla and then removing the breast. Therefore it will be seen that now when we do the "complete Halsted" we do "Willy Meyer's operation."

For comparison one should refer to the present status of the surgery of carcinoma of the breast. I think the recent publication of the conclusions of the Committee on Cancer of the British Ministry of Health will just about tell the story for surgery the world over.

"The average expectation of life for a woman with cancer of the breast, without operation, is 3.25 years. Those operated upon may be classed average and best cases. The average person comes for treatment more than 1 year after discovery of the lump; the average duration of life is 5.74 years. Even in these the expectation of life has been more than doubled."

The best have no glandular or skin involvement and of those 85 per cent remain free from recurrence after 10 years.

Still our results are not perfect, and we must constantly try to better them. Early diagnosis and still earlier removal must be our aim. We should insist on one short and simple answer to the question "How do you make a diagnosis of early cancer of the breast?" and that answer

[1] Read before the Western Surgical Association at Duluth, Minnesota, October 15, 1926.

Fig. 1. The incision used by the author when the original tumor is situated in the breast as in the ordinary case. The arm is abducted and the upper transverse incision reaches from the middle of the clavicle to the posterior axillary line, crossing the axilla, keeping away about 1 inch from the arm.

Fig. 2. The skin flaps are reflected. The blade of the knife should be turned away from the skin (the artist has made a mistake) cutting parallel with the skin and not more than a quarter of an inch away from it. The skin is reflected to beyond the opposite parasternal line, above the clavicle, well out onto the shoulder beyond the first incision and back to the posterior axillary line on the same side. The bleeding is controlled by hot wet towels packed in as one goes along.

should be: "By early removal of the lump and its microscopic examination."

As an interne it fell to my lot to dress certain cases on which the Halsted operation had been done. The space bridged by loose and baggy skin reaching from the chest wall to the shoulder and arm never failed to become infected, and suffering and disability were the rule. Many have been the expedients tried in order to get this skin to lie close against the vessels throughout their course and to prevent the formation of "dead space" especially when the arm was abducted. None of the accepted incisions has ever allowed this to be done successfully.

You have noticed how the tailor in fitting you uses two flaps to draw the cloth close into the axilla—if we can fashion our flaps somewhat on his lines our problem is solved.

The author has been using the method here described and advocated since 1910. In a previous communication the method was published and the cases reported; and now after having used the method in over 50 cases the results are published in order that the method may be given a trial if it is considered worthy, perhaps by those having a wider experience.

Usually there is too much skin remaining out toward the axilla. If there is anything in Handley's theory of the spread of carcinoma, the presence of the strip extending from breast to axilla is a menace. Rodman must have believed this.

The incision from mid-clavicle to posterior axillary line or beyond follows a straight line. As it crosses the base of the axilla it is not more than 1 inch from the arm as this lies alongside the body. The posterior flap is grasped at its tip (which should be rounded and drawn hard up toward the clavicle, the higher the better) and fastened there. No room is left for a drain in the fornix under the flap. If this flap heals where it is

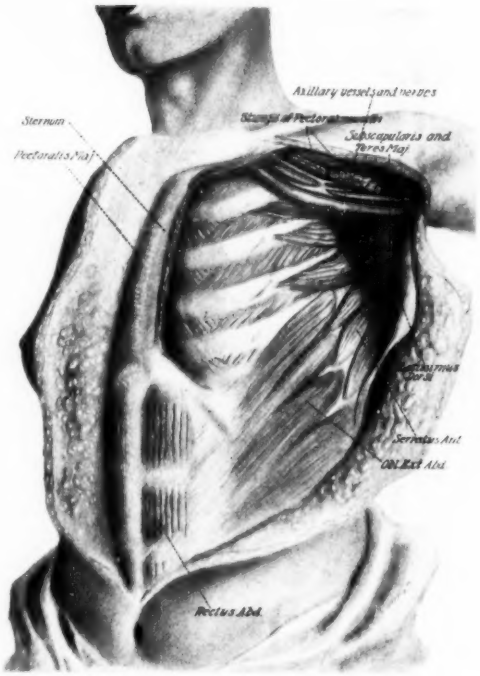

Fig. 3. After cutting through both muscles close to their insertion and reflecting them medially we dissect the axilla from above downward and then all of the mass consisting of the skin, breast, both muscles, fat, glands, and fascia is reflected *en bloc*.

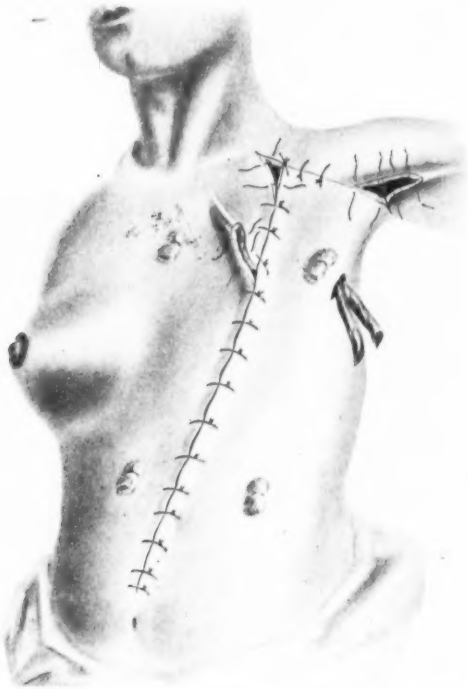

Fig. 4. Showing the manner of closure. With a towel clamp the outer angle of the lower flap is grasped and drawn up as far as possible toward the clavicle, at the same time another clamp grasps the outer angle of the upper flap and draws it medialward out of the way. This maneuver draws the skin firmly into the angle between the shoulder and body and obliterates dead space. If redundant the skin should be trimmed accordingly. The space in this angle must be obliterated. It is now seen that the original first incision buckles at its lower end. This gives the cue as to how it should be closed as in the illustration. It leaves a projecting little nodule of skin and fat which is soon absorbed. A similar nodule is formed by the turning inward of the outer end of the medial flap. Tension sutures, always at least two, sometimes four, as illustrated, are used. Owing to the wide undercutting, it is remarkable how large a defect can be closed. In the angle underneath the outer flap, drains may be placed. These are removed at the end of 24 hours.

put, the function of the arm is assured. The raw surface on the outer side of the flap is now closed. The upper flap is swung over according to the method of Jackson and the rest of the wound closed by undercutting or left for skin grafting.

A boiling water sterilizer is kept going right across the table during the operation. Throughout the whole operation great care is taken not to cut through normal tissue with a contaminated knife. All the clean work is done first. No instrument is used without first being dropped into the boiling water sterilizer from which a nurse picks it out and replaces it on the tray; thus none but clean instruments are on the tray.

While we are removing the mass from the chest wall, we rely on the use of hot wet towels, not sponges, and hand pressure to control bleeding. The vessels are clamped and tied later. Very little blood is lost as a rule. The removal of the underlying fat and fascia is very wide, from above the clavicle to the level of the navel, and from beyond the farther parasternal line to the posterior axillary line of the same side.

Of course there are atypical cases, for example those in which the cancer has begun high up in the margin of the breast or well over toward the sternum. These are handled accordingly.

SHOCK

Until 1925 shock had no terrors for me, though previous to that I had had to treat it and had lost

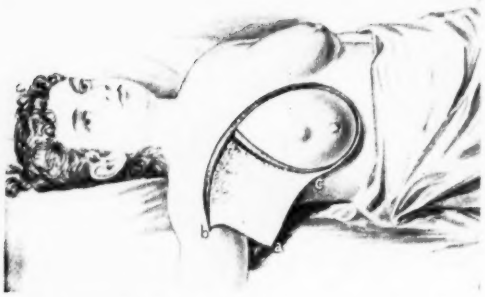

Fig. 5. Halsted's original incision. (From Ann. Surg., 1894, xx, 497.)

a case from shock during the evening following operation. But in 1925 I lost 3 patients, 2 certainly as a result of shock. The third patient, having rallied, was found during the night to have a temperature above 109 degrees F. It was very hot weather. She lived 3 days, delirious, though her hands and feet died the second day (turned black). The pathologist found "fibrinous peritonitis, and a recent perforation of the lower ileum." There had been no abdominal symptoms whatever.

INFECTION

There has never been an infection in any of our cases in which the complete operation has been done.

Our method of closure minimizes the amount of dead space and hence lessens the liability to postoperative infection. This perhaps is not much of an advantage to surgeons who can do their own dressings. But when dressing must be left to an assistant anything that makes it safer is of course of distinct value.

COMPLICATIONS

Pneumonia occurred once, in a fat patient 49 years old. The operation had taken 3 hours and 20 minutes. The neck had been dissected, and the cautery had been used to sear the chest wall. The woman developed a cough and purulent streptococcus bronchitis. After the wound had healed and all sutures were out, she fell out of bed while the nurse was sleeping and tore the axilla open again. She died after 4 weeks, no postmortem and no roentgenograms of the chest (1916) being made.

RECURRENCE

By recurrence is meant re-appearance of the cancer in some part of the area from which it is supposed to have been removed. Its first manifestation is a lump either in the scar or under the skin flaps. Recurrence is of two kinds, that which appears in the operative area only and that appearing in the operative area and elsewhere in the body. This last form of recurrence is in my opinion just a part of the general dissemination. Of the first variety, that which ensues because of incomplete removal or faulty handling, there have been 6 cases.

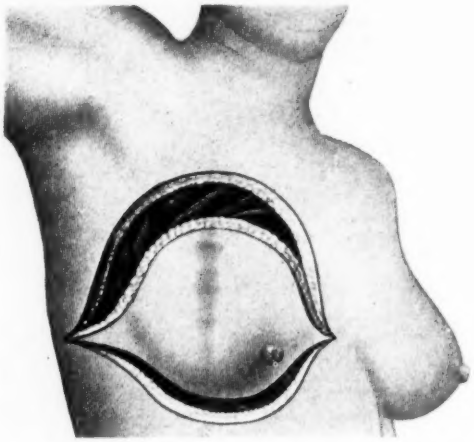

Fig. 6. Stewart's original incision. (From Ann. Surg., 1915, lxii, 250.)

One of these cases has an interesting history. A strong, rather lean, married woman of 40, with 2 children, both breast fed, was operated upon in 1912 for a tumor, the size of a walnut in the right breast. It was a scirrhus and the breast showed chronic interstitial mastitis. The glands were negative. One year later a nodule appeared just below the clavicle and I removed it. It was necessary to resect about 1½ inches of the axillary vein. I charred the clavicle with the cautery and cleaned out the neck. In 1920 she came with a lump in the left breast. I removed the lump and another pathologist pronounced it "sub-involution with cyst formation." I then removed the breast and the lowermost axillary glands. One year later she came with a nodule under the flap. I removed it and the same pathologist reexamined it and reported scirrhus carcinoma of the breast. She is still quite well.

Another patient came back in a year with a hard nodule fixed to the second rib near the sternum. The cancer was of scirrhus type and had been present over a year before operation. It was the size of a hen's egg. The axillary glands were involved, and the nodule was cancerous. I

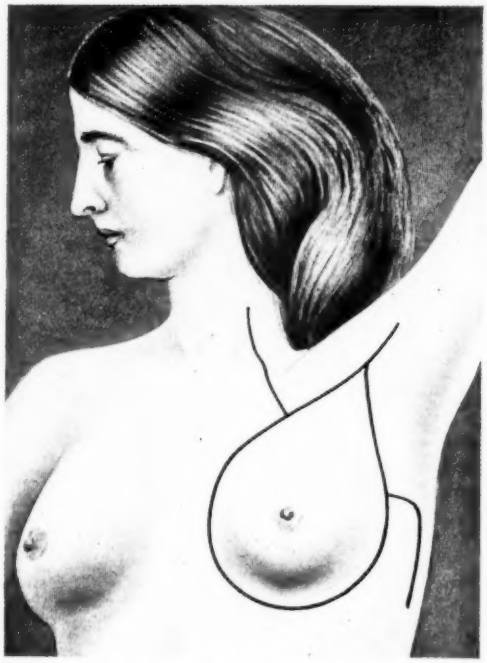

Fig. 7. J. C. Warren's original incision. (From Ann. Surg., 1904, xl, 805.)

Fig. 8. J. N. Jackson's original incision. (From J. Am. M. Ass., 1906, xlvi, 627.)

cooked it well and then removed the portion of the rib involved and let it heal by granulation. The patient is well after 5 years.

Another patient, aged 40, fat, nursing a first baby of 6 months, discovered a nodule. She had it removed with a paste. It recurred in 7 months. I then did a complete operation. The axillary glands were involved. I later removed the lower glands of the neck. The lowermost showed carcinoma. One year later a nodule appeared in the skin of the neck in the angle between sternomastoid and clavicle. This was diagnosed as adenocarcinoma of the breast. She is well now after almost 3 years.

Two patients have had recurrence in the intercostal spaces close to the sternum. In both cases I cauterized and cut and am using the X-rays. One of them is now better than she was 2 years ago when a year after operation she came back with the recurrence; the other was operated upon only 4 months ago and her cancer is growing. The sixth returned in 6 months with cancerous nodules everywhere in the operated area, also in the skin of the back (same side) to within a hand-breadth of the spine. She did not live a year altogether (10 months after her first operation).

In 4 of those in whom recurrence took place in the field of operation sometime after evident widespread metastases, 1 lived 2 years, the others were dead within a year after operation.

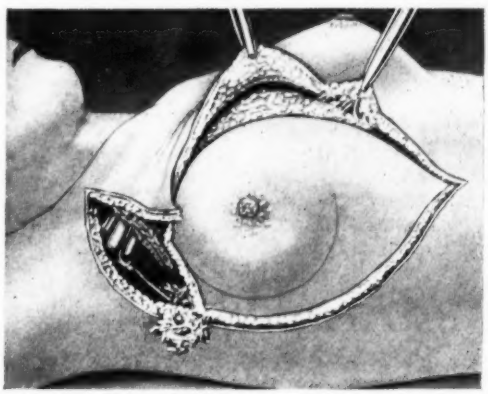

Fig. 9. Rodman's original incision. (From Rodman, *Diseases of the Breast*, 1908.)

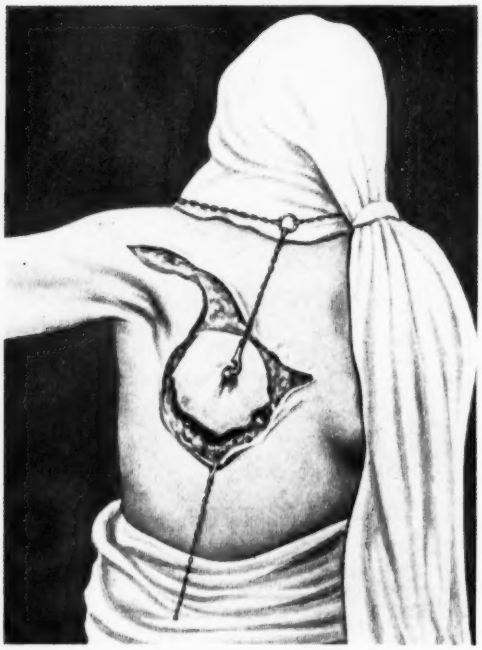

Fig. 10. Willy Meyer's original incision. (From Med. Rec., 1894, 746; J. Am. M. Ass., 1905, xlv, 207.)

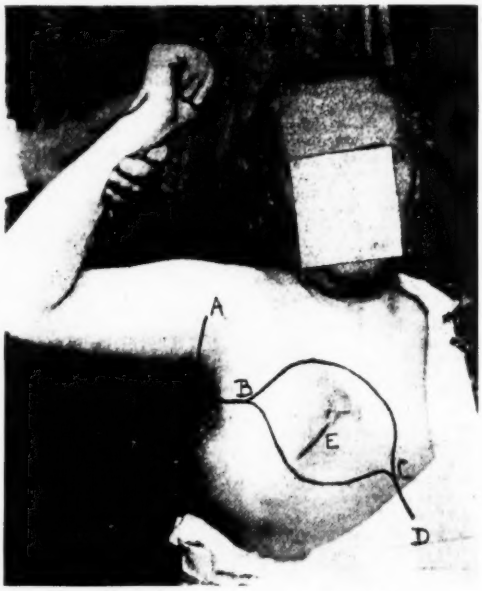

Fig. 11. Sampson Handley's original incision. (From Brit. M. J., 1904, ii, 832.)

I believe that in these cases the recurrence is a part of general dissemination which occurs before operation.

METASTASES

One thing that surprised me very much indeed was the frequency of metastases to the spine. I have had in this series 6 such cases, and I have encountered perhaps as many more in consultation. I was also somewhat startled to learn that metastases to the spine might come late and be limited to one spot as seen by the following case.

Mrs. H., 56, a working widow, knew of the lump in the right breast "for a year or so." It was as large as a turkey's egg and axillary glands were involved. She too was fat. The type was adenocarcinoma. She was operated upon in 1914 and was quite well until 1921 when she developed lumbago. She died late in 1922 having lived about 8½ years. The postmortem was complete and the only cancer anywhere to be found was where the fourth lumbar vertebra had been.

Another patient lived 6 years and then developed spinal metastases (presumably). None of the others with spinal metastases lived more than 2 years.

I have learned that when a patient formerly operated upon for cancer of the breast develops chronic rheumatism or lumbago, to suspect metastases to the spine or pelvis as the cause of the condition.

In a case of rapidly growing adenocarcinoma in a girl of 16, the tumor had been noticed more than a year and in the past 3 months had grown from a nodule "the size of an olive" to a mass larger than the other breast. It was quite 4 inches across and lay to the inner side of the breast. The skin over it was warmer than that elsewhere and the veins were enlarged and tortuous over it. It felt like a lipoma but harder. It was encapsulated. But owing to the microscopic appearance and the history of rapid growth a complete operation was done. The glands were negative. She is well 2⅓ years later.

SUMMARY

There have been 50 operations, and in 10 cases only 2 years or less have elapsed since the date of operation.

Of the 50 cases there were 5 deaths in the hospital after operation. The cause of death was shock in 3, heat stroke in 1, gas gangrene in 1, and pneumonia in 1; an operative mortality of 12 per cent.

Of the 40 operated upon more than 2 years ago, 24 are now living and 16 are dead.

Of the 16 patients who died, 3 died in the hospital after operation, 1 as the result of gas gangrene, 1 of pneumonia, and 1 of shock. One patient died 3 years after operation of pneumonia. In 12 cases the cause of death is known or believed to have been cancer. That is to say, 3 out of the 40 died as a result of the operation and 25 out of 37 are believed to have died of cancer.

Of the 24 living, 1 has been living 13 years, 2 for 11 years, 1 for 10 years, 3 for 7 years, 1 for 6 years, 4 for 5 years, 8 for 4 years, 4 for 3 years. Of those who died of cancer since operation, 1 lived 8½ years; 1, 6 years; 1, 4 years; 4, 2 years; 3, 1 year; 2, less than 1 year.

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CLEFT PALATE REPAIR—THE CAUSE OF FAILURE IN INFANTS AND ITS PREVENTION

By STERLING BUNNELL, M.D., San Francisco

THE main cause of failure in repairing cleft palates, especially in infants, is the sucking action of the tongue. Having become convinced of that fact, I devised the following means of keeping the tongue away from the palate and since their adoption have found that repairs have been successful.

Before using the method I found it almost the rule in infants for the palates to partially break down in the first or second week after the repair. Even after the closing of the palate in a way that seemed surgically correct, that is, by using massive flaps, with good blood supply, with exact apposition and freedom from tension, it was usual in infants for the suture line to break down either in its posterior half or in its center in a varying number of days. Then as the palate healed, the result improved a little as the contraction of the scar in the cleft drew the closed apex of the cleft backward, much like the tendency for webs to reform after some operations for syndactylism. Thus, after repeated operations, the palate was finally closed, but was then often found to be short, so that in speech or deglutition it did not act well as a valve to shut off the nasopharynx.

The sucking power of an infant is surprisingly great, as is easily demonstrated by feeling the pull exerted on a finger inserted in a baby's mouth. As measured by a manometer on a series of newborn babies this force averaged 152 millimeters mercury, the highest being 200 millimeters. In adults it averaged 440 millimeters. From this it is readily calculated that the force exerted on the palate in the average newborn infant is 7 ounces times the number of square centimeters of the palate that are involved in the sucking.

$$\frac{13.6\ (\text{Wgt. of Hg}) \times 15.2\ (\text{height of col. in cm.})}{30\ (\text{No. of gm. in } \mathfrak{Z}1)} = 7\ \text{oz.}$$

The infant whose palate has been recently operated upon will probably not suck with the same great strength of the normal infant, but it will suck with a formidable proportion of this strength in spite of the pain. Is it then surprising that our sutures in such a delicate structure as a baby's palate cannot withstand this repeated trauma and strain? While the palate remains completely united the strain of the suction between it and the tongue is great, but as soon as any part of the suture line gives way the suction is broken, in part at least. For this reason, it is rare for the complete length of the suture line to hold after an operation done in the sucking age, which is, in the first 16 months. Even in young children the constant and uncontrolled action of this strong and muscular organ, the tongue, jeopardizes our surgical repair.

It is advisable to close the cleft in the palate at a very early age and the method about to be described makes this possible. Nutrition is then improved by normal nursing and feeding. The correct habit of modifying vocal sounds, which attainment is our main object in repairing palates, is then established early, long before articulate words can be produced. The earlier the palate is closed the better will it develop, as in the first years of life there is the greatest growth. Also the earlier the repair the less is the mental anguish of the parents. Surgeons have found by experience that a delay of operation, even as long as for a few years, increases the probability of success in obtaining a closure. Brophy, whose experience is great, stresses the need of closing the cleft early, that is between the sixteenth and twenty-second months, so that correct habits of articulation will be formed as speech starts. He delays operation until that time, because as he states, "The mucoperiosteum removed from the bones is frail and likely to break down."

The method to be described will allow closure of the palate during the first few months of life and will improve the result of operation done at any age.

PRELIMINARY PROCEDURES

Soon after birth the alveolar processes are pressed into alignment and held there by Brophy's method of wires and plates. In from two weeks to a month, as soon as the baby has a grip on life, the lip is repaired. The first is a minor procedure, but the repair of the lip and nose is attended by even more hæmorrhage than is the repair of a palate and so may prove fatal, especially if the baby, as is often the case, has malnutrition. A 50 cubic centimeter Luer syringeful of the mother's blood transfused with an ordinary

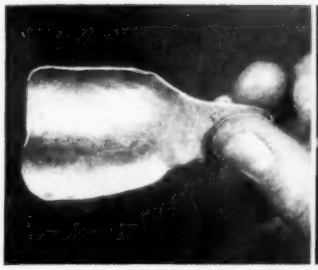

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 1. Metal spoon for holding the warm dental wax up against the alveolus to make the wax impression.

Fig. 2. The wax impression of the alveolus.

Fig. 3. The dental artificial stone has been poured onto the wax impression which is perfected by working the wax all around the alveolus with the fingers.

needle by cutting down on the baby's median basilic vein immediately postoperatively will prevent death from hæmorrhage. Such a small amount of blood can be given by this simple method before it has time to clot in the needle. One should always at the end of each operation suspend the baby by the feet to pour the blood and mucus out of its trachea as a baby cannot cough it up. One to three months later when the baby is strong enough, the palate can be closed. This is done in two stages, a week apart, in order to have time to make our protecting false palate and to gain the advantage of a certain principle established in plastic surgery.

In this, the mucoperiosteal flaps are separated from the bone sufficiently to reach together without tension and are then immediately replaced to where they were, without sutures, and left for a week. Lateral freeing incisions are avoided when possible and are never extended backward through the muscles and vessels of the soft palate. At the end of the week the blood vessels in the pedicles will have increased in capacity so that the flaps will be sufficiently viable to more readily stand being moved from their beds and sutured together. The flaps will also be found to be much thicker. One stroke of a blunt instrument will free them from their beds, with very little bleeding. Their edges are trimmed off and sutured with horsehair. The wires and thin metal plates of Brophy can also be used on the soft palate.

THE PROTECTING FALSE PALATE

In order to protect the palate from the damaging action of the tongue a metal false palate prepared from an impression of the baby's mouth (Figs. 5, 6, and 7) is held in place up against the alveolus under the palate to wall off the tongue during healing.

At the first stage of the operation before the flaps are freed, an impression of the alveolus and palate is made with dental wax by the usual method used by dentists. The wax softened in warm water is placed on a spoon-like sheet of aluminum fashioned to fit the alveolus (Fig. 1) and is pressed by the finger held under this spoon against the roof of the mouth. The wax is worked all around the alveolus by fingers pressing through the cheeks and lip.

In the interval between the two stages of the operation, the protecting false palate is prepared. First, a counter impression from the wax is made with dental "artificial stone" (Figs. 3 and 4). From this a false palate of sheet silver (gauge 28) is made in a dental laboratory. Soldered to it are two silver wires (gauge 16) which are made to run directly downward from the region of the lateral incisors and are later bent to fit the baby's face. Multiple perforations are made in

Fig. 4. The counter impression of artificial stone ready to send to the dental laboratory as the form of the alveolus for making the protecting false palate of silver. The area where the silver false palate is to make contact with the patient's alveolus has been marked with crayon.

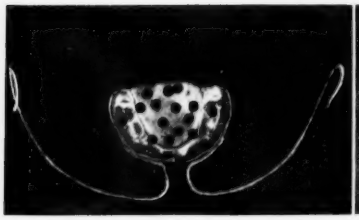

Fig. 5.

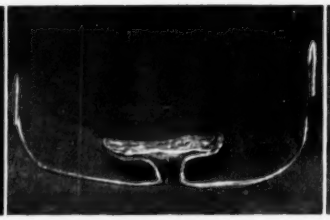

Fig. 6.

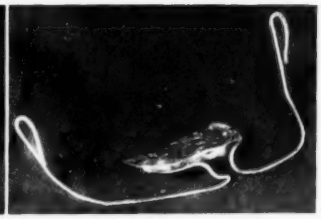

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Figs. 5, 6, and 7. Showing the finished protecting false palate of silver with wires attached and bent into position. The silver plate is ready to be held up against the alveolus by rubber bands attached to the hooks on the wires. The views are top, front, and diagonal respectively.

Figs. 8 to 13. Showing the protecting false palate of silver held in place by thin rubber bands to the plaster bandage which encircles the head. The repaired palate is thus protected from the sucking action of the tongue for 12 days while the suture line is healing. The photographs also show the results on the harelips and nasal deformities which were repaired before operation on the palates.

the false palate so that a screen effect is produced for drainage.

On the completion of the second stage of the operation, in which the palate is repaired, a plaster of Paris band is placed about the baby's head and incorporated in this in a frontal plane with the center of the palate are placed wire hooklets, each for the attachment of a narrow rubber band, such as druggists use. The protecting false palate is then placed under the upper alveolus, and the stiff wires are bent around to fit the face and to hook over the two rubber bands that hang from the plaster head band. By these bands the plate is gently held in place against the alveolus protecting but not touching the sutured palate. The wires should be so bent that they emerge from the mouth so as not to touch the lips. Then each wire is made to pass laterally around the outside of the cheek, and then to bend vertically upward and terminate in a hook for the attachment of the rubber band. The hooks of the wires should be in such a frontal plane with the center of the palate that the plate is lifted up against the alveolus with equal pressure in both its front and back parts.

The baby's arms, with elbows extended, should be encased in plaster of Paris.

The surgeon's mind will then rest assured that the tongue, which is the arch enemy of the repair of the palate, will not break down his handiwork.

In the after-treatment great care must be maintained to insure cleanliness. It is advisable to have a special nurse, but if this is impossible, each and every floor nurse attending the baby should be carefully instructed how to clean and guard the palate from injury. After each feeding the false palate should be lowered vertically and kept in a parallel plane with the palate, to allow the plate and palate to be irrigated. The top of the plate should be sponged off with a cotton swab daily and by touching the suture line and surroundings every few days with a 1 per cent alcoholic solution of brilliant green and crystal violet, necrotic material may be rendered inert as a culture media. With this care, the baby's mouth can readily be kept clean and free from odor. Feeding is done through a catheter introduced to the pharynx.

The stitches are removed on the twelfth day under anæsthesia and the false palate is left in place 2 days longer.

Since the above method has been in use it has been a satisfaction in each successive case to see the repair of the palate hold throughout its entirety, while before the adoption of the method, almost invariably the palate when repaired in infants broke down, at least in part.

THE IDEAL IN HERNIORRHAPHY

A New Method Efficient for Direct and Indirect Inguinal Hernia[1]

By W. WAYNE BABCOCK, M.D., F.A.C.S., Philadelphia
From the Surgical Department of Temple University

SKIN INCISION

THE incision for inguinal hernia should be in the line of skin cleavage or nearly transverse. Oblique incisions, flap incisions, or those that invade the scrotum, usually give a poor scar and are unnecessarily mutilative. The art of surgery should not be disregarded even in an abdominal incision, for artistry in a surgeon's scars is apt to mirror artistic skill throughout the operation. A badly made, crudely sutured skin incision of the abdomen, at once suggests, and often correctly, a weakened abdominal wall or incisional hernia, intra-abdominal adhesions, and other evidence of technical defect in the operation.

If a previous operation has been done in the same field, the old scar should be excised to give the operative approach. It is a curious mutilative impulse that impels the operator to insist on making a fresh incision in spite of the presence of one or more disfiguring scars in the neighborhood of the operation.

Art necessitates the taking of pains in one's work. Desire for personal convenience, expedition, ease, cannot excuse a poorly placed and crudely closed wound when the patient's safety is not involved. Scrotal incisions involve an area difficult to sterilize.

A normal incision for inguinal hernia, therefore, is one which passes transversely directly over the internal inguinal ring, from a point just within the semilunar line to a point slightly external to Poupart's ligament (Fig. 1).

SPLITTING THE EXTERNAL OBLIQUE APONEUROSIS

The thinnest and weakest portion of the external oblique muscle lies over the inguinal canal. If the fibers are split above or below the line of the canal, one flap will have toward its base the weak area. If the fibers are separated directly over the canal, the edges of the flaps or the parts best supported in the closure will be weakest, which makes for the strongest mechanical closure of overlapping edges. If the separation is made by scissors or with a grooved director, the underlying iliohypogastric nerve may be caught and divided. Therefore, the external oblique should be carefully split by a scalpel from without inward between the thinnest and most widely separated fibers that are found over the hernial canal.

The outer surface of the external oblique should not be freed from adherent fascia and nutrient vessels, but the under surface should be freely separated by blunt dissection from the underlying internal oblique muscle, and from the inner anterior layer of the sheath of the rectus to the midline. This mobilization of the deeper muscular layers is of great advantage in enabling a satisfactory closure of the canal, and the freeing of the rectus has been especially emphasized by De Garmo. The inner and shelving portions of Poupart's ligament should be wiped free from all fat and adventitious tissue by a gauze sponge.

OPENING THE HERNIAL SAC

The hernial sac should be approached from without inward, from above downward in the canal and near the internal ring. If one searches in the region of the external ring or scrotum, he may be below a small sac. In approaching the sac, tissues are picked up and divided between hæmostats. The hæmostats should not crush vessels or nerves, and are not to be removed until the sac has been located and opened. Each layer invaded should be indicated by an additional pair of hæmostats. In this way the operator has a means for identifying each layer entered, and does not repeatedly pick up, explore, and re-explore the same tissue. The tissue layers to which tissue forceps have been attached are avoided until the sac is opened, when the forceps are removed. The operator should not raise the cord or explore tissue behind the cord. If the sac is not promptly found, he should not continue to traumatize the region of the cord, but by retracting the internal oblique and transversalis upward and outward, expose and open the peritoneum just mesial to the internal ring. Then, with an exploring finger within the peritoneum, the problem is immediately solved. A very thin collapsed sac, a small incomplete hernia, a direct hernia, a femoral hernia, a wide and bulging conjoined tendon or other condition may be found. In any case when the sac is opened, it is wise to introduce the finger and examine for any other sac or weakness, or other adjacent interabdominal disease,

[1]Partially described in Surgical Clinics and Surgery, Gynecology and Obstetrics, 1911.

such as an inflamed tube or appendix. A number of recurrences after herniorrhaphy have been due to an overlooked sac which such an examination would have instantly revealed.

TREATMENT OF THE SPERMATIC CORD

Transplantation of the spermatic cord is not essential in the successful operative treatment of inguinal hernia. The older statistics of Bloodgood, in which 500 cases without cord transplantation showed slightly better results than 500 cases with transplantation, are not unusual. Naturally, a poorly performed operation without the transplantation should not be expected to compete with a better technique and transplantation. The surgeon partisan to and especially experienced in the Bassini operation may personally have better results than with his own non-transplanting operation, but his results should be compared with those of a surgeon especially skilled in the non-transplanting technique.

A personal experience is illuminating in this regard. In over 3,000 inguinal herniorrhaphies only 11 patients have returned for recurrence. Four of these were strictly not recurrences, but consisted of persistent direct inguinal hernias, not recognized and not corrected at the first operation. The true recurrences followed unusual physical strain during the first week or weeks of convalescence, a violent postoperative cough being a common factor, obese and asthmatic middle aged patients giving the chief trouble. Thus the recurrences started before firm union had occurred in the deeper layers of the wound. It is reasonable to believe that were the recurrences due to failure to transplant the cord, or other technical defects, some would have been delayed for months after an uneventful operative convalescence, just as we so often find in the recurrent hernias after Bassini's operation. Furthermore, in these patients returning with recurrence, as well as the much larger number treated for recurrence after the Bassini operation, transplantation of the cord has not been found necessary for the final successful result. One apparent secondary recurrence has been observed. The first operator did a Bassini operation, but overlooked a direct hernia. At the re-operation the cord was also replaced but the direct hernia again overlooked. At the third operation the direct hernia was found and successfully corrected without retransplanting the cord. No other instance has been observed in which the technique here given has failed at the second operation.

By leaving the cord alone one eliminates most of the postoperative complications in the scrotum.

Fig. 1. Line of incision for herniorrhaphy. A nearly transverse incision 10 to 14 centimeters long, centering over the internal inguinal ring. This involves a portion of the abdominal wall easily sterilized and gives a linear, almost invisible scar.

As a rule, it is also important not to injure or ligate the spermatic veins. In one case in which a swollen testicle was explored after ligation of two-thirds of the veins for varicocele, the gland was found to be necrotic. Bloodgood has emphasized this danger. Therefore, transplantation or manipulation of the spermatic cord is usually unnecessary and undesirable in the operative treatment of inguinal hernia.

TREATMENT OF THE HERNIAL SAC

The hernial sac should be eliminated, especially its funnel-like mouth, and the neck of the sac should be transplanted behind a part of the abdominal wall that is strong and thick. The inversion of the sac advocated by Kocher need not be practiced, but his idea of transplantation of the neck of the sac is important. In congenital and infantile hernias, and in certain sliding and very large scrotal hernias, division of the neck and retention of the body of the sac in the scrotum are desirable.

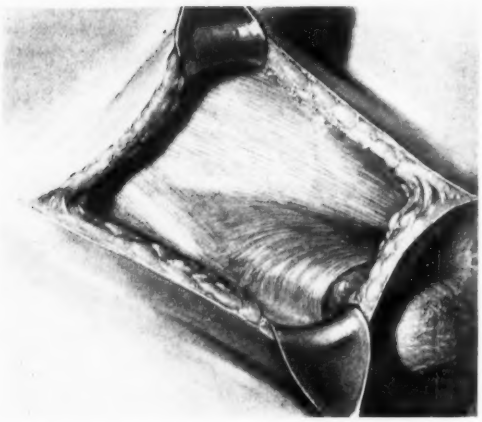

Fig. 2. Division of superficial (fascia of Camper) and deep fascia (fascia of Scarpa), showing enlarged external inguinal ring and bulging anterior wall of inguinal canal, with darker triangular area, marking the thinner portion of the aponeurosis of the external oblique over the inguinal canal where the fibers have been separated.

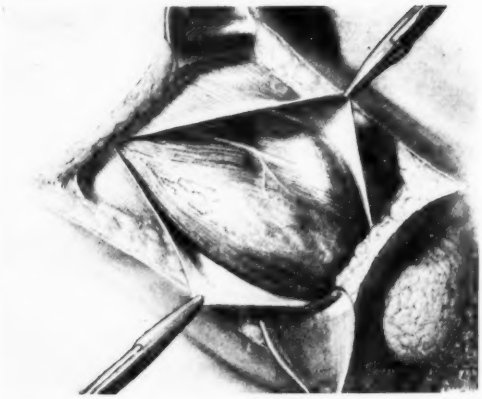

Fig. 3. Separation of the fibers of the external oblique aponeurosis directly over the canal from the external inguinal ring, upward and outward, exposing the internal oblique muscle, the cremaster muscle, the hernial sac and spermatic cord.

Fig. 4. Hernial sac exposed and raised on the finger showing attached underlying vas deferens. The vas is not transplanted, not disturbed, and often not seen.

DEEP SUTURE MATERIAL

Good chromicized catgut is entirely efficient for the deep closure in herniorrhaphy. Its desirable lengths, smoothness, strength, and absorbability, give it advantages over other known suture materials. Kangaroo tendon is no longer necessary for a successful closure. Aseptic silk and strips of homologous fascia produce less tissue reaction, but have compensating disadvantages.

LAYER SUTURE

Strength in the union of the layers of the abdominal wall comes from the fibrous aponeurotic expansions, not from the suture of red muscle, out of which sutures readily tear. Red muscle gives good support, however, when backed by a strong fibrous sheath or aponeurosis. Below, the chief support is to be obtained from Poupart's ligament, its shelving edge, and the dense fibrous covering of the pubis; above and internally, from the conjoined tendon, the fibrous inner layer of the anterior sheath of the rectus, and the external oblique. Bloodgood's transplantation of the rectus muscle by opening its sheath, weakens the wall. Much better is the transplantation of the muscle in the sheath.

CLOSURE OF HESSELBACH'S TRIANGLE

In inguinal herniorrhaphy, the most troublesome area of weakness lies in the lower inner angle, the area of the conjoined tendon. This is the area that has been difficult to strengthen and it is weakness here that has been responsible for

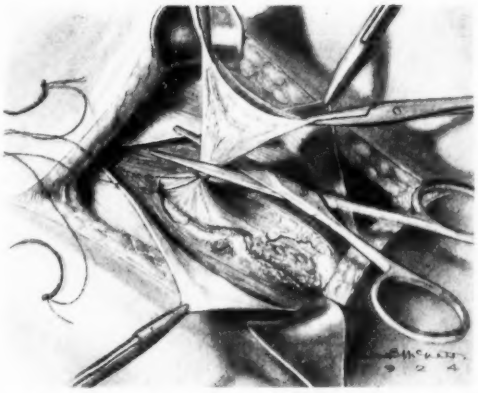

Fig. 5. The hernial sac has been opened, liberated to the internal ring, the contents reduced, the neck transfixed and ligated by a double-ended armed ligature, the ends of which will be used for transplanting the neck of the sac and for closing the inguinal canal.

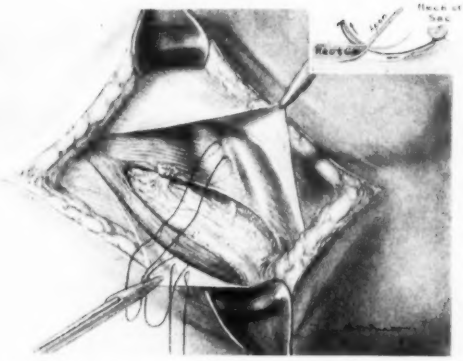

Fig. 6. Transplantation of neck of sac and transplantation of rectus muscle. The ends of the ligature from the neck of the hernial sac have been brought through the edge of the rectus muscle and the inner layer of its overlying sheath. The ends of the ligature have then been passed from within out through the shelving edge of Poupart's ligament, so that, when tied, the neck of the hernial sac will be transplanted behind the edge of the rectus, and the edge of the rectus in its sheath approximated to the shelving portion of Poupart's ligament. For strength in the closure the sheath of the rectus is not opened.

most recurrences. The transversalis fascia and the conjoined tendon are structures of uncertain strength, and often are not to be depended upon. Occasionally operators have registered their discouragement by asserting that many direct inguinal hernias could not be cured by operation. A solution of this problem lies in obliterating Hesselbach's triangle by uniting the lateral edge of the inner layer of the anterior sheath of the rectus to the dense fibrous covering of the pecten ossis pubis. The pecten ossis pubis is the continuation of the ilio-pectineal line forming a distinct ridge along the posterior superior margin of the ramus and body of the pubis. It lies about 13 millimeters back of the spine of the pubis, and the bone is here covered by a very dense and strong ligamentous or aponeurotic covering, several millimeters in thickness, which gives a more secure hold for the needle and suture than does the aponeurosis of the external oblique, or the shelving edge of Poupart's ligament. The covering of the bone is reinforced at this point by fibers from the pubic end of Poupart's ligament (ligamentum inguinale), Gimbernat's ligament, Cooper's ligament, the ligament of Henle (falx inguinale) and the ligament of Colles (triangular fascia or ligament inguinale reflexum). This tough ligamentous structure with its firm bony fixation is, therefore, admirably adapted for suture.

NARROWING THE INTERNAL ABDOMINAL RING BY SUTURE OF THE TRANSVERSALIS FASCIA

The narrowing of the internal abdominal ring by suture of the transversalis fascia is not dependable and may be ignored. Often the transversalis fascia is so thin and tenuous as to be exposed with difficulty, and gives little support when sutured. By the suturing of the internal oblique and transversalis muscles to the shelving portion of Poupart's ligament, or better, the inner layer of the anterior sheath of the rectus to the shelving portion of Poupart's ligament, a sufficient obliteration of the internal ring is secured. When this union is reinforced by the imbricating of the overlying external oblique, a competent support to the internal ring and inguinal canal is obtained.

TECHNIQUE

The steps of the herniorrhaphy are well shown by the accompanying illustrations. The aponeurosis of the external oblique is exposed by nearly a transverse incision following the line of skin cleavage and centering over the internal inguinal ring. The superficial epigastric artery, the superficial external pudic, the recurrent branch of the superficial circumflex iliac vessels are divided between hæmostats, the fibers of the external oblique are freely separated over the inguinal canal and the edges reflected. The hernial sac is located, opened, and the contents examined and reduced. The sac is isolated or divided at the neck, and the neck is transfixed and ligated at a high point by a long No. 1 or 2 chromic catgut suture, each end of which is armed by a needle. The needles are

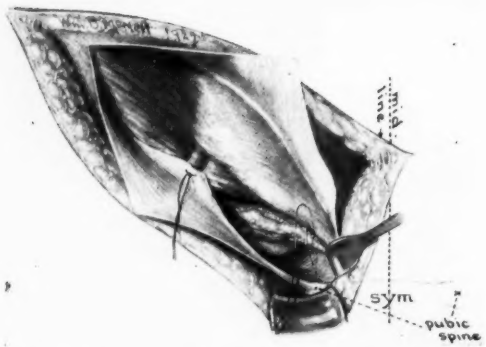

Fig. 7. Obliteration of Hesselbach's triangle. The inner layer of the anterior sheath of the rectus muscle in its lower portion is being sutured to the thick tough ligamentous covering of the posterior superior edge of the pubis, posterior to the spine of the pubis and to Poupart's ligament. The shelving portion of Poupart's ligament with the attached mattress suture that has served to transplant the neck of the hernial sac is shown.

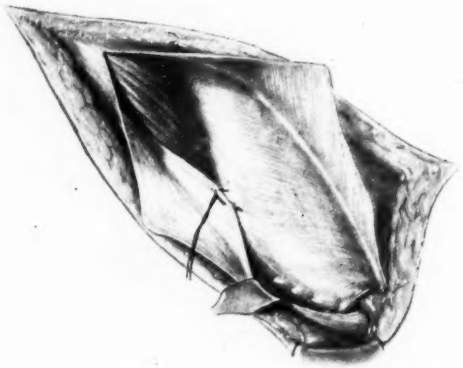

Fig. 8. Obliteration of Hesselbach's triangle continued. The area of the conjoined tendon has been obliterated by suturing the lateral edge of the lower part of the rectus within its sheath to the strong fibrous covering over the pubic portion of the iliopectineal line in front of the spermatic cord. In its mesial portion the suture line lies posterior to the spine of the pubis, to the triangular fascia (ligament of Colles or ligament inguinale reflexum). Laterally the suture line is posterior to Gimbernat's ligament and to Cooper's ligament. These sutures fold the conjoined tendon and the ligament of Henle (falx inguinale) against the pubic bone and the ascending ramus of the pubis. This union strongly blocks the crural canal from above, preventing femoral hernia, reinforces the weak internal angle of an indirect inguinal hernia, and solves the problem of the radical cure of direct inguinal hernia. Care must be taken that the suture line is not carried so far laterally as to impinge on the femoral vessels.

carried from beneath the transversalis fascia through the edge of the rectus, and the suture pulled taut, transplanting and pulling the neck of the sac behind the rectus muscle. If the conjoined tendon is weak, the upper surface of Poupart's ligament is cleared by gauze dissection, the spermatic cord, conjoined tendon, edge of the rectus and triangular fascia retracted at the inner angle toward the opposite side. The superior surfaces of the body and ramus of the pubis are cleared by gauze dissection above and posterior to the spine of the pubis. The ridge of the pecten ossis pubis is located with its thick fibrous covering, and to this the lateral edge of the rectus covered by its inner sheath is sutured by two or more interrupted or mattress sutures. Experience has shown that, if the edge of the rectus is sutured behind the spermatic cord to the fibrous covering of the pubis, the cord may be compressed and strangulated. However, if the suture is made anterior to the cord, there is usually no interference with the circulation. Laterally care should be taken to avoid the femoral vessel. These sutures obliterate Hesselbach's triangle, and also effectively close the femoral opening from above. If a femoral hernia is present, the sac is entered by opening the peritoneum through the inguinal canal. It is emptied, grasped at the fundus by hæmostatic forceps, inverted into the wound, the neck of the sac transfixed, ligated, or sutured, and the sac removed. Returning to the suture ends from the ligation and transplantation of the neck of the inguinal sac, one carries the two needles through points on the shelving portion of Poupart's ligament, corresponding with their points of emergence from the rectus muscle, and ties the suture ends. This approximates the edge of the rectus muscle, covered by the inner layer of its sheath to the shelving portion of Poupart's ligament. From this central point of attachment, one suture is continued laterally and upward, uniting the internal oblique and transversalis to the shelving portion of Poupart's ligament. Often the muscles show a normal attachment along this line and do not require suture. This is the area where recurrences need not be feared. The other suture is continued medially and downward, uniting the inner layer of the anterior sheath of the rectus to Poupart's ligament. The suture of the anterior surface of the rectus at its lower angle to the shelving portion of Poupart's ligament, narrows the inguinal canal and crowds into it and toward Poupart's ligament the lower portions of the internal oblique and transversalis.

Union between muscle and aponeurosis acquires strength only when the muscle is backed or

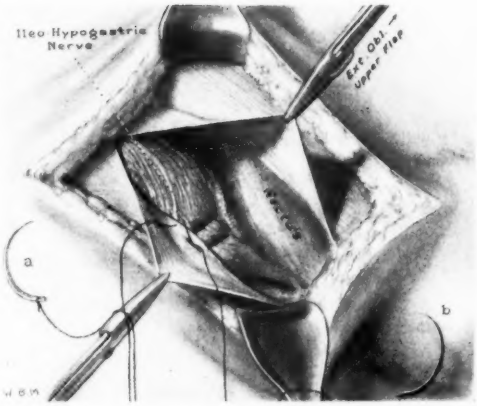

Fig. 9. Suturing of internal oblique and transversalis muscle to shelving portion of Poupart's ligament. The suture ends from the ligation and transplantation of the neck of the inguinal sac having been carried through the shelving portion of Poupart's ligament from within out are tied. One suture, *a*, is continued laterally and upward uniting the internal oblique and transversalis to the shelving portion of Poupart's ligament. Care must be exercised in order not to injure or compress the iliohypogastric nerve. Suture *b* is continued medially and downward uniting the inner layer of the anterior sheath of the rectus to Poupart's ligament.

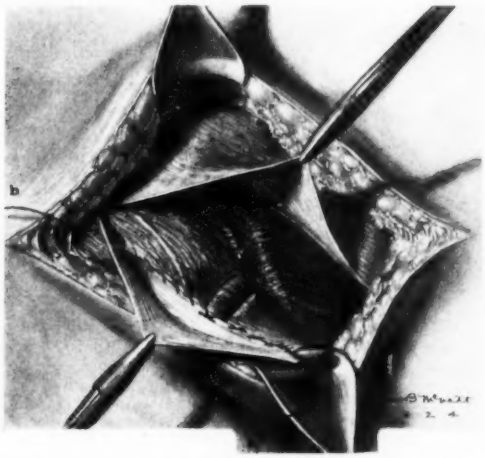

Fig. 10. Suture of the internal oblique and transversalis muscles to the shelving portion of Poupart's ligament by a continuous suture completed, the ends of the suture being brought through upon the anterior face of Poupart's ligament as shown at *a* and *b*. In this case, to prevent undesirable tension, the edge of the rectus has not been closely apposed to Poupart's ligament. Usually the inner half of Poupart's ligament can be apposed and sutured to the edge of the rectus sheath. If this cannot be done without undue tension, the internal oblique and transversalis muscles are sutured to the shelving portion of Poupart's ligament as indicated. With a strong conjoined tendon, the closure of Hesselbach's triangle by suturing the sheath of the rectus to the pubis is unnecessary.

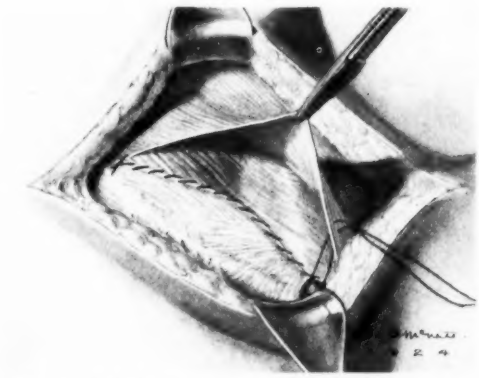

Fig. 11. Imbrication of Poupart's ligament by a continuation of one of the sutures, the lower flap of the external oblique aponeurosis, including Poupart's ligament, covers the previous suture line and is attached to the internal oblique laterally and to the inner layer of the anterior sheath of the rectus mesially. The ends of the suture are now brought through the upper flap of the external oblique at its inner angle and tied. Hesselbach's triangle has now been reinforced by suture lines with imbrication uniting strong aponeurotic structures in these layers.

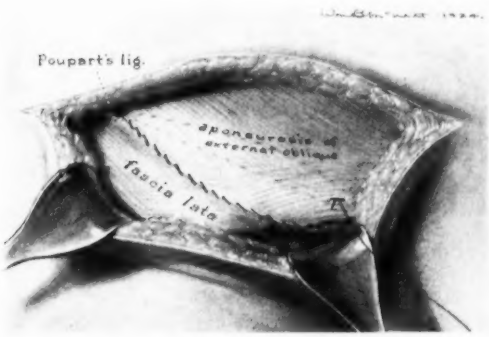

Fig. 12. Closure of the aponeurosis of the external oblique muscle. The upper edge of the opening through the aponeurosis of the external oblique has been brought down, lapped over Poupart's ligament and the edge sutured to the fascia lata by a continuation of one of the continuous sutures previously used. The neck of the hernial sac has now been transplanted and the inguinal canal narrowed and reinforced by four strong layers of tissue with imbrication.

Fig. 13. Narrowing the external inguinal ring. If the external inguinal ring is large or more than a narrow slit, it is reduced in size and reinforced by sewing the edge of the external oblique at the lower angle to the sheath of the pectineus muscle. As a rule, this is not required. If the spermatic cord has not been transplanted, the projecting spine of the pubis will prevent compression of the associated vessels. Transplantation of the cord is undesirable and should not be used with this technique.

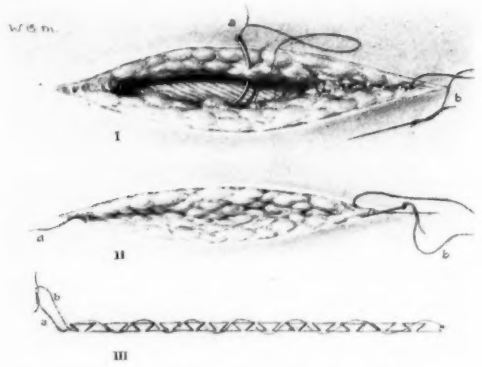

Fig. 14. Closure of the superficial and deep fascia by a continuous buried and intracuticular suture of fine plain catgut, all knots being buried.

covered by a fibrous aponeurosis. The union of the internal oblique and transversalis to the shelving portion of Poupart's ligament is, therefore, reinforced by turning up the flap from Poupart's ligament and the lower edge of the divided external oblique and suturing this to the anterior surface of the inner layer of the sheath of the rectus, by a continuation of one of the sutures. The upper free edge of the aponeurosis of the external oblique is now pulled down over the preceding suture line and united by its edge to the denuded fascia lata giving a double imbrication. At the lower mesial angle, the suture line may be reinforced and the external ring narrowed, by suturing the upper edge of the aponeurosis of the external oblique to the sheath of the pectineus by one or two single mattress sutures. Unless there is great weakness, this is unnecessary.

The operation may be done with a single double-ended continuous suture which is tied at the completion of each row, or by partially continuous or interrupted sutures according to the operator's fancy. The skin is closed by interrupted or buried sutures, or by Michel clips. A thick pad is strapped over the wound and supported by a firm spica bandage, which should not compress the abdomen above the level of the iliac crests. The spica is renewed once each week, or whenever it becomes loosened. The patient is kept flat in bed for from 10 days for children and young robust adults, to 18 days for middle aged or senile patients, or those with much fat or with poor muscular and aponeurotic development. If the wound becomes indurated or inflamed, yellow oxide of mercury ointment is applied and the patient is kept in bed until the induration has subsided.

As a rule, the patient leaves the hospital in from 14 to 21 days after the operation, with instructions to report weekly, or whenever the spica becomes loose, for rebandaging, to avoid active work for 6 weeks, and lifting for 3 months. At the end of 6 weeks all bandages are removed; at the end of 3 months the patient is permitted to do full work.

We believe that a herniorrhaphy properly performed, followed by primary union, will not break down under any ordinary stress applied later than 6 weeks from the time of operation.

Recurrence not due to defect in technique or in the wound healing, usually results from the separation of the lines of suture during the first 2 weeks after the operation, caused by severe cough, violent vomiting, persistent hiccough, or by the patient sitting up, or getting out of bed. Every effort should be made to protect the suture line from stress during the early period of healing, especially should cough be prevented. Recurrences, even from direct inguinal hernia should be very rare. All inguinal hernias that may safely be reduced are curable by operation.

THE INJECTION TREATMENT OF VARICOSE VEINS BY THE USE OF SCLEROSING SOLUTIONS

By H. O. McPHEETERS, M.D., F.A.C.S., Minneapolis, Minnesota

THE treatment of varicosities of the leg with their various and oftentimes disabling results has been an ever-present source of worry to men of the medical profession. Many patients are made invalids for the remainder of their lives and during all that time are in constant distress and discomfort.

Oftentimes patients with large varicosities have little or no discomfort and then again, patients with veins of the same size and location suffer a great deal of pain. The best explanation regarding the cause of the pain is the increased tension on some of the terminal nerve filaments as they penetrate to the skin. Patients often complain of rheumatic pains in the knee and ankle or through the lower leg, when in reality these are all due to the extensive varicosities present, even though they may not be obvious on first inspection.

ANATOMY

The accompanying charts from Spalteholtz show how profusely the branches of the venous system in the lower leg intercommunicate, there being arches in all directions and these in turn communicating with a deeper system of veins. The long saphenous with its collaterals is the one usually involved. Most often the varicosity begins just internal to and below the knee, next about the middle of the lower leg internal, then about the ankle. The short saphenous forms over the upper part of the calf and extends upward joining the deep system just above the popliteal space. Here we often find the largest varicosities of all. There is very often a large varix over the patella and another above this on the inner side of the leg as a branch of the long saphenous. There is a varix of the superficial group of the upper inner part of the thigh below Poupart's ligament extending about the vulva which drains into the femoral vein through the oval window in the fascia lata 2 inches below Poupart's ligament. In some cases this causes much pain.

ETIOLOGY

The etiology of varicosities is practically always explainable on an obstructive basis, and this obstruction is brought about in several ways:

1. By pressure due to tight bands, most commonly about the knee.

2. By obstruction developing at the oval window in the fascia lata of the thigh where the superior edge seems to cause an obstructing band above, and the inferior cornu resting under the superficial saphenous causes pressure below as this vein dips deep to join the femoral vein. Dr. Philip Turner, of London, in a paper in 1923, emphasizes the frequency of this condition as one cause of the obstruction.

3. By obstructions above Poupart's ligament which would mechanically cause a retardation of the return venous flow, due to (a) pregnancy—varicosities very frequently develop during the early months of pregnancy and increase as gestation goes on; (b) constipation; (c) tumors of the pelvis causing obstruction on either or both iliac veins; and (d) occupations requiring that the patients be on their feet long hours at a time.

PATHOLOGY

For a discussion of pathology of varicose veins I would refer you to any standard textbook. There is a degeneration taking place in the wall of the vein giving varicosities of all types. These types are the simple, cricoid, varicose, and anastomosing. In any of these, a thrombus may form which may become organized, thus occluding the vein, and which may be the source of an embolus.

Oftentimes the dilatation becomes so marked and the stagnation in the external saphenous system so advanced that the circulation becomes retrograde with the flow downward in the external system, returning through the deep system of veins. This is very easily and clearly demonstrated by Trendelenburg's experiment.

TREATMENT

The treatment of varicose veins and ulcers is as varied in type and as numerous as any other subject in medicine. An excellent summary of the operative methods was made by Dr. J. M. Hayes[1] in 1925. The old and established treatment of varicose ulcers has been an attempt at sterilization of the ulcers locally, followed by a supporting band to the whole leg to avoid the associated stagnation. As a method of sterilizing the ulcer and aiding the healing, a saturated solution of

[1]Hayes, J. M. J. Lancet, 1925, January.

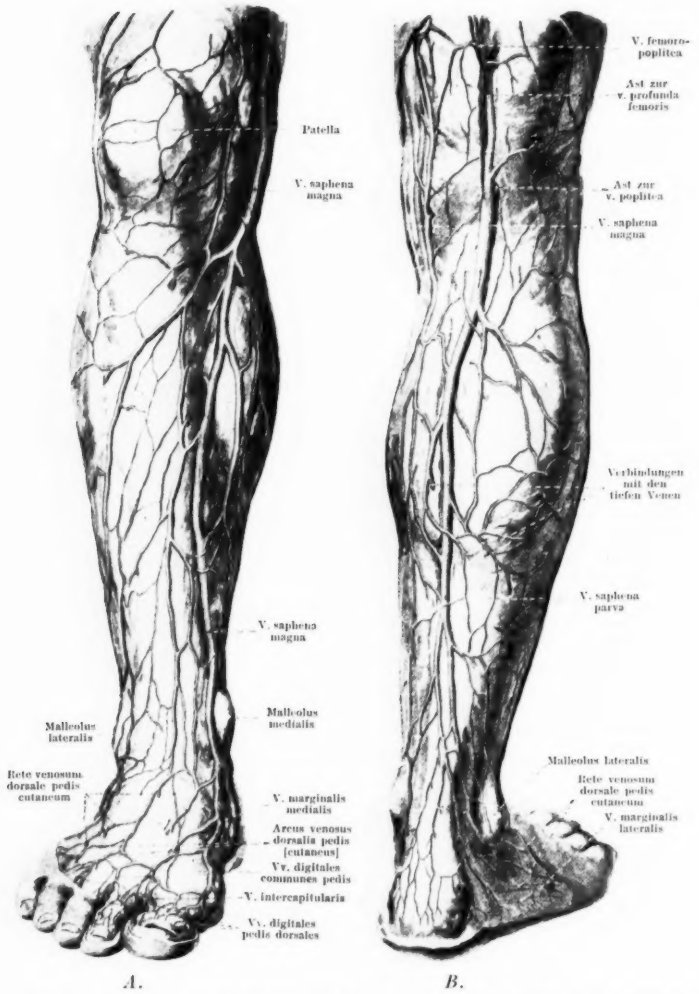

Fig. 1. The anatomy of the superficial saphenous system. *A* and *B* below the knee and *C* above the knee. (From Spalteholtz's *Anatomy.*)

picric acid on a wool sponge, bandaged in place with pressure and changed every 2 days, gives good results. A silver nitrate stick to the edge of the ulcer at the time of treatment facilitates healing. Another treatment is to cleanse the ulcer with benzine and then apply a disc of rubber tissue trimmed somewhat larger than the ulcer and held in place by a zinc glue bandage, which is practically the same as Unna's paste, from the toes to the knee. This paste should be put on warm, smeared on thick and wrapped with a 4-inch gauze bandage, so that the gauze and paste together form a cast or mold to the leg. A rubber sponge is then placed over the ulcer and another bandage applied. This gives pressure directly over the ulcer area. The application is left in place 3 or 4 weeks and then removed. The ulcer is cleansed with benzine and the bandage reapplied. Talcum powder applied to the leg before the paste is used tends to prevent irritation. By the use of Unna's paste, compression and support are obtained which prevent the stasis that is

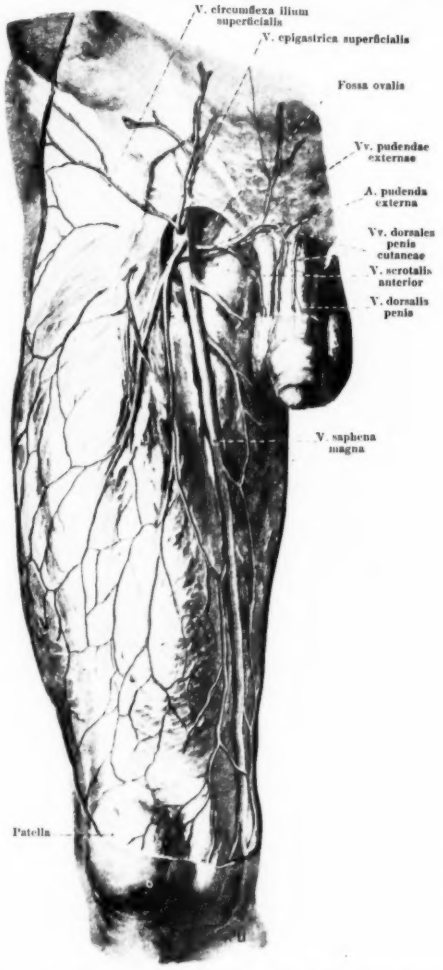

Fig. 1, C. The anatomy of the superficial saphenous system above the knee.

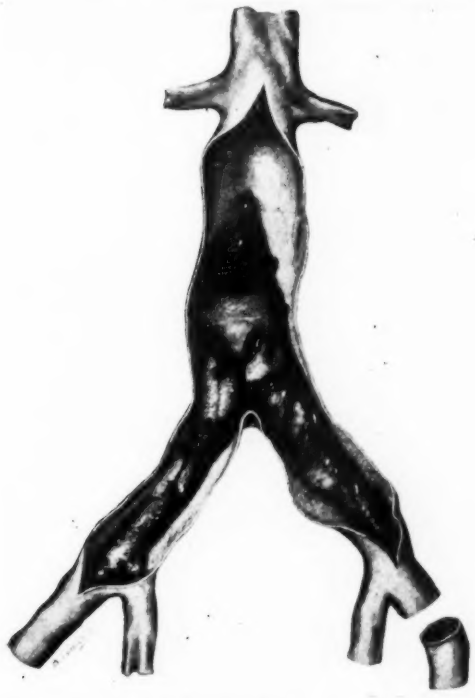

Fig. 2. To illustrate the ordinary thrombus formation. Note the intact and normal intima. (From McCallum's *Pathology*.)

thought to be the active factor in the production of varicose ulcers. In the treatment of varicose ulcers the coarse hydropic granulations seem continually to overgrow the other fine epithelial islands and thus destroy them. The pressure with the rubber sponge just spoken of cares for these granulations better than does any other method. It is advisable to leave another pad with the supporting cast on the leg for at least a month after all healing has taken place.

In any treatment for varicose veins, three things must be considered: first, the removal of the cause of the trouble; second, the excision or destruction of the veins which are causing the trouble; and, third, the preservation of the deep saphenous vein which is the main channel for drainage of the lower extremity.

The importance of the ambulatory treatment in the care of varicose veins and ulcers cannot be overemphasized; it is the one great advantage of the injection treatment over the operative method.

There are serious objections to operation.

1. There is no more assurance that the varicosities will not recur after the operative method than after the injection treatment if the latter is done just as thoroughly.

2. The danger of embolism is ever present. It may occur in the hands of the most competent surgeon. A check of the records of three hospitals of this city shows that during the year of 1926, in a series of approximately 7,000 operations, there occurred 16 deaths from postoperative embolism, a percentage of one death from embolism per 500 operations performed.

3. 4. 5. 6. 7. 8. 9. 10. 11. 12.

Fig. 3. Mr. C. H. before the injection.
Fig. 4. Mr. C. H. after 3 injections.
Fig. 5. Mrs. J. F. H. before the injection.
Fig. 6. Mrs. J. F. H. after 6 injections.
Fig. 7. Mrs. L. B. before the injection.
Fig. 8. Mrs. L. B. after 5 injections.
Fig. 9. Mrs. C. A. before the injection.
Fig. 10. Mrs. C. A. after 8 injections.
Fig. 11. Mrs. N. L. before the injection.
Fig. 12. Mrs. N. L. after 15 injections.

3. Under the operative method the patient must be confined to bed. Immediately upon getting up the feet begin to swell and this swelling persists at times from 4 to 6 weeks.

4. The scars of the operation are sometimes unsightly and may be more disfiguring and annoying than the varicosities.

5. The anæsthetic, the pain and discomfort of the dressings, and the removal of the clips or sutures cause a much greater annoyance to the patient than the slight cramp-like pains of the injection method.

The greatest objection to the injection treatment is the theoretical possibility of embolism secondary to the thrombus which may form. Dr. E. T. Bell, professor of pathology at the University of Minnesota, with reference to this possibility of embolism, says: "Regardless of how much experimental work might be done, it would be impossible to rule out the ever present *theoretical* possibility of the danger of embolism with fatal termination, but in view of the fact of the large number of cases injected, both at home and abroad, I feel that the *practical clinical* evidence of thousands of injections having been made, with but one fatality from embolism would be more than sufficient to outweigh the ever present theoretical danger."

Solutions used in the injection treatment.

1. *Twenty per cent solution of common salt.* Many of the leading men have now discarded the other solutions in favor of this harmless and non-toxic agent. Linser, who has been the pioneer in this work, hailed the use of salt as a "real advance" over the other solutions formerly used by him. The salt solution can be used without fear of toxic effect and in amounts of 5 cubic centimeters to 10 cubic centimeters to the injection. Thus it is of much greater value in the large varices with many branches. The sole objection to its use is the cramp-like pain which it stimulates through the extremity below the site of the injection. This pain usually lasts about 1 minute and then is gone entirely. Many patients insist that this cramp-like pain is no more than they have daily when on their feet.

The use of novocain has been suggested several times in the literature but, as far as I know, it has never been used in this connection. I have used a 1 per cent, 2 per cent and 3 per cent novocain in 20 per cent salt solution, but without benefit. The patients who had no toxic effect or symptoms of collapse with the previous injections now developed a true novocain shock, which seemed to be more severe as the stronger novocain solution was used. This was used in three cases before I realized the significance of the reaction and stopped its use. The last patient developed a novocain shock lasting a day and a half from which she nearly died. When one stops to consider the experiments and clinical work of men like Dr. R. E. Farr and how he always insists that one must *never* inject the novocain solution, even in ½ of 1 per cent strength until he has aspirated and knows that the needle point is *not* in the vein, it is clear that it should not be used in this connection.

The salt solution should never be injected except when one is *sure* that the needle point *is within* the lumen of the vein. Repeated aspirations should be made during the process of injection to determine this. If there is any doubt,

stop at once, as the injection of this fluid into the perivascular tissue will cause a sloughing. This, however, is a break in technique and not an objection to the method or solution used.

2. *Mercuric chloride 1 per cent.* The difference between the effective dose and the fatal dose is so small that it should not be used. It has been discarded by many of the men who have worked in this particular field. The sloughing which follows a poor injection with careless technique is more intense and heals more slowly than with the other methods.

3. *Glucose 50 per cent.* This solution is so thick that it cannot be used with 26 gauge needle and the larger needle leaves such a large opening in the vein that there is definitely more chance of the solution oozing out following the withdrawal of the needle. The solution, however, is not toxic and is the method used by several European clinicians.

4. *Sodium salicylate 20 per cent, 30 per cent and 40 per cent.* This solution has been used as much, if not more than any of the other solution previous to the last year. Siccard and Parauf of Paris have done the most work with this preparation. However, some patients have a definite idiosyncracy to it somewhat similar to that to quinine. They test their patients first with small doses. In any case, the maximum total dosage is 3 grams. The sloughing which follows a poor injection is the same as that which follows the use of the other solutions. The cramp-like pain in the extremity is the same as that following the salt. As to efficiency it is as good as any.

5. *Mercuric chloride 1 per cent and ammonium chloride 1 per cent.* This solution is open to the same objections and criticisms as were given for the mercuric chloride.

6. *Calorose.* This is an invert sugar preparation which at present is being used very extensively in Vienna. It is thin and causes no pain and has given good results. It should be given further use.

7. *Alcohol.* No logical argument can be offered in favor of this solution in the light of our experience with other less toxic, less dangerous, and yet more efficient solutions.

8. In addition to these, there are used *Pregl's solution*, which is an iodine preparation, *pyoktannin*, and several others.

TECHNIQUE

1. Examine the patient carefully, using the Trendelenburg test. This is in a great measure to determine whether or not the deep system of veins might be occluded and, if it is, then the destruction or removal of the superfician system would naturally be interdicted.

2. Select the site of injection. This should always be at the upper edge of the varicosity.

3. Sterilize the skin with alcohol.

4. Mark the dilated saccules or varicosities to be injected with mercurochrome.

5. Place the tourniquet in position but do not tighten it.

6. The type of syringe is one of the most important points in the success of the operation. One, such as the Luer lock syringe in the 5 cubic centimeter and 10 cubic centimeter size, with the rings for the fingers and thumb, is by far the best. There are many such syringes on the market. These give one more absolute control of the needle point and, at the same time, both the injection of the fluid and the aspiratoin of the blood are more easily performed. With the ordinary Luer syringe, it is easy to withdraw the needle from the vein or force it through the tortuous loop, if it happens to be a small vein, as you shift your hands when trying to aspirate and then inject. Determine whether or not the needle point is in the vein and thus avoid the solution being deposited in the tissue.

7. Use a No. 26 gauge needle. The larger size needle will leave such a large hole in the wall of the vein that the fluid may ooze out, particularly if it is under pressure. The bevel on the large needle is so long and the wall of the vein so thin that with the small veins the needle point may be sufficiently in the lumen of the vein to aspirate the blood and yet as one injects, the solution may go into the perivascular tissues. Since the saline does not cause coagulation of the blood, there is no danger of the needle becoming occluded even with this fine lumen.

8. Be sure the needle point is well in the lumen of the vein. If not, *do not inject.* Withdraw and let this particular vein go until a future time.

9. Do not inject the vein under too much pressure, as this may cause two things: (a) an oozing backward following the withdrawal of the needle; and (b) if the varix is very thin walled, with perhaps all the muscle layers ruptured in one spot, the vein may actually rupture here with an effusion of the blood and solution into the perivascular tissue. Control this pressure by elevation of the leg and the use of the tourniquet.

10. Leave the needle in one minute following injection, and try to localize the fluid as much as possible by the tourniquet and elevation.

11. Immediately following the withdrawal of the needle put a small gauze pad for pressure directly over the needle puncture and follow this

by a bandage tightly bound. A 4-inch woven cotton elastic bandage similar to the ace bandage is by far the most efficient for this purpose. The bandage is left on for 2 days; it is then removed and rebandaged for 2 days longer. The pressure pads of gauze will have caused a collapse of the vein at the site of injection and often the walls will have so adhered by this time that the vein will not refill. This is an important point in the technique and one not sufficiently stressed in the literature. The patient always feels more comfortable for several days following the injection, if the bandage is continually reapplied.

12. The number of injections must be decided entirely by the case in hand—usually one for small veins and three to five for the larger ones. At one sitting, I have often made three to six separate injections, depending upon the total amount of material used and how much the patient minds the distress of the injection. I have used as much as 60 cubic centimeters of a 20 per cent salt solution in 5 cubic centimeter to 10 cubic centimeter injections, with no untoward results. This patient, however, developed a sense of thirst, warmth, and slight faintness which passed off in about 10 minutes.

RESULTS

1. *Immediate at the time of injection.*

a. The patient develops cramp-like pains through the leg distal to the site of injection, at times even into the foot. This pain seems to bear no relation to the caliber of the vein injected or to the extensiveness of the varix. It is best explained on a basis of the strong salt solution penetrating the vein walls and directly stimulating the muscle fibers of the leg, thus causing a cramp similar to the experiment of saturated salt solution on the frog's muscle. Others have explained it on the vasomotor basis of an intermittent claudication. This does not seem reasonable because the patient does not have the same vascular disturbance in the toes and foot as in the former condition.

b. At times there will be a sudden collapse of the vein, distal to the site of injection, as the fluid enters. This collapse may extend 3 to 8 inches downward. It usually occurs in the veins about the size of a lead pencil, and is caused by the direct stimulation of the contractile fibers in the vessel walls. When followed by the pressure pad and bandage, the collapsed vein may never fill again, though usually it does.

2. *Remote or later results.* When the patient returns on the second day, the vein is often hard and tender. It may be hard and cord-like to the size of one-fourth to half inch in diameter and at times throughout a distance of 3 to 8 inches. If the intima has been destroyed and the pressure pad has been sufficient to hold the vein collapsed, there will be no hard thrombus, but, on the contrary, the former varicosity can scarcely be located. This means that the walls of the vein under the effect of the pressure following the injury to the intima have actually agglutinated and sealed together. There are three reports in the literature on the histopathology occurring in the vein after the injection. The most complete work was by R. Bazelis in his Paris thesis in 1924. These results are duplicated and confirmed by G. L. Regard, a surgeon and privat docent of the University of Geneva, Switzerland. The latter's work and opinion have been accepted as positive and of real value. V. Meisen, M. D., surgeon-in-chief of the Copenhagen Policlinic, in an address delivered before the Medical Society of Copenhagen, October 20, 1925, gives a most thorough discussion of the whole subject and his reports of the histopathology are identical with those of the two authors cited above. These reports prove conclusively that the pathology developing in the vein after the injection is exactly what would be expected. The intima is destroyed and the vein becomes entirely obliterated through the agglutination of the walls, in one case, and in the other, the organization of the chemically produced thrombosis with the vein walls. Ultimately, this leaves a mere fibrous cord. Regard concluded his report with this remark: "The danger of embolism is to be feared no more than in ordinary surgery or in the accidents of daily life."

3. *The untoward results.* (a) The painful cramps have been previously discussed. (b) A burning or smarting in the tissues will occur if the fluid is outside the vein. This burning is positive assurance that some of the fluid is in the perivascular tissue and will cause a subsequent slough which is painful, sore, and tender, but which progresses with very little discharge and leaves a clean base that heals fairly readily. The separation, however, is slow.

4. *Recurrence.* Some of the larger veins may take three or four injections before they are obliterated, the vein getting thicker walled and more leathery all the time.

5. *Fatal results.* A search of the literature on the subject shows but two deaths following the injection of varicose veins by the use of sclerosing solutions. One of these was reported by Hohlbaum.[1] Hammar[2] reports another case. Linser,

[1] Hohlbaum, Zentralbl. f. Chir., 1922, xlix, 218.
[2] Hammar Deutsche med. Wchnschr., 1919, xlv, 45.

in his last article in 1925, says that he has used it in thousands of cases with no fatal results in any form and that he has never heard of any other than the two cases mentioned above. In Hohlbaum's case the final decision was that the death was due to a fat embolus and not from the thrombosis direct. In Hammar's case the patient died from mercurial poisoning. The onset of the symptoms began a few hours after the treatment, the patient dying on the twelfth day.

CONCLUSIONS

This report is based upon the clinical results in a total of 31 cases having received approximately 180 separate injections.

1. The results are conclusive evidence that the injection treatment of varicosities with 20 per cent sodium chloride solution is superior to other methods, operative or otherwise.

2. The danger of death from embolism, though *theoretically* ever present, *practically* and *clinically* is almost nil.

3. The treatment is ambulatory, permitting patients to continue their usual routine of work.

4. The patients are spared a great expense, as all hospital bills are avoided; they are not compelled to leave their work for 4 to 6 weeks (which often means losing their positions).

5. If good technique is used all sloughing can be avoided.

6. The cramp-like pains through the leg, distal to the site of injection, are no more severe than many patients have daily.

7. It is a simple matter to repeat the treatment if the varicosities recur.

8. Unless the blood is repeatedly aspirated back into the syringe, *do not inject.* When in doubt, *don't.*

9. The results are so uniformly satisfactory and so easily accomplished, and so little risk to life is entailed, that I believe surgery for the treatment of varicose veins, other than in a few selected cases, will soon be a thing of the past.

I wish to acknowledge my indebtedness to Dr. F. J. Souba for his courtesy in extending to me the privilege of his research connection and also to Dr. Daniel H. Bessesen for his translation of German articles.

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FOREIGN BODIES IN THE BRONCHUS OF INTRAPULMONARY ORIGIN

Report of a Case[1]

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CALCIFICATION in the lung, pleura and mediastinal lymph nodes can be often demonstrated roentgenologically in apparently healthy persons. It is an almost constant finding on postmortem examinations of adults and is usually attributed to the healing of a tuberculous lesion. In most cases this is a beneficial process, but in rare instances one or more of the calcified hilar lymph nodes ulcerates into the bronchus. In such a case the calcified mass may give rise to all of the symptoms produced by any foreign body aspirated through the mouth.

Many writers have emphasized the necessity for suspecting a foreign body of extrinsic origin in the bronchus in all cases of pulmonary suppuration, but that a foreign body may arise within the chest and cause equally disastrous results has not been emphasized. A number of cases of stones in the lung have been reported in which the diagnosis was made after the patient had coughed out one or many calcareous masses (1, 2, 3). In a previous paper (4) a case was reported in which a patient was relieved of chronic pulmonary suppuration by the removal bronchoscopically of a large amount of calcified material from the lumen of a bronchus. The calcification apparently had followed the aspiration of a tooth pick. The case reported herewith shows the difficulty of diagnosing the condition and how a fatal outcome may result from the prolonged sojourn of the foreign body.

A man, aged 53, was examined in the Mayo Clinic, January 4, 1927. In 1918, he had had influenza followed by moderate cough and expectoration but with little impairment of general health. In August, 1926, following exposure, the cough and expectoration increased and was accompanied by fever and general debility. The sputum was purulent with a foul odor. Three weeks before his examination, a severe pulmonary hæmorrhage had occurred. There was no history of the aspiration of a foreign body.

The patient was weak and was admitted to the hospital on his arrival at the Clinic. The temperature varied from 100 to 101 degrees and was of a septic type. Examination of the sputum revealed spirilla and fusiform bacilli only. There was marked limitation of movement on the left side with many moderately coarse râles throughout the lower lobe of the left lung. A roentgenogram revealed what appeared to be an abscess corresponding with the pathological area found on physical examination. On January 11, a bronchoscopic examination showed a stricture in a bronchus in the lower lobe of the left lung. This was dilated and a large amount of foul pus was aspirated.

Following evacuation of the secretion, the patient's general condition improved markedly, and within 4 days the temperature was normal. After 7 days of normal temperature and general improvement, pain developed suddenly on the left side of the chest and the temperature rose to 102 degrees. The symptoms were attributed by the patient to the fact that he had lain on his left side during the previous night. He was unable to bring up any pulmonary secretion and it was thought that a sudden obstruction in the bronchus had occurred. A second bronchoscopic examination was made although the patient was desperately ill. At this time, there was little pus in the bronchus, but three small pieces of calcareous material were removed from the bronchus below the stricture (Fig. 1). It was then decided that empyema had occurred, and thoracentesis revealed a small amount of pus at one point of puncture, clear fluid at another and old blood at a third. This led to the conclusion that the empyema was multilocular and further operation was deemed inadvisable. Death occurred shortly.

Necropsy disclosed empyema with multiple sacculations, chronic tuberculous infection of the left lung and hilar lymph nodes, marked calcification of the lymph nodes and their apparent erosion through the bronchial wall. At the division of the left main bronchus was an area of scar tissue that evidently marked the prolonged sojourn of a foreign body. In the bronchus below the point of stricture were two large calcareous deposits lying free in the bronchial lumen (Fig. 2). Evidence of terminal pneumonia in the lower lobe of the right lung was also found.

If the empyema had not resulted fatally, it is likely that with repeated dilatations of the bronchial stricture the foreign bodies could have been removed through the bronchoscope with restoration of the patient to normal health.

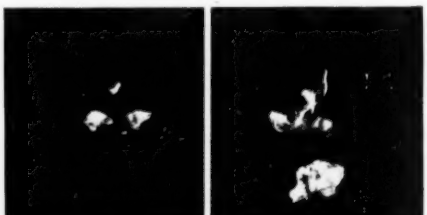

Fig. 1. Calcified material removed at the time of second bronchoscopic examination.

Fig. 2. Large calcareous masses found in bronchus at the postmortem examination.

[1] Submitted for publication February 17, 1927.

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SOME MINOR MODIFICATIONS OF HARVEY CUSHING'S SILVER CLIP OUTFIT

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FOR some years Cushing has been using small silver clips in place of ligatures to control bleeding when operating on the brain. Many surgeons doing neurological surgery have adopted these clips, and feel that they form a very important adjunct to their technical equipment. Despite a good deal of personal attention, the writer has had considerable difficulty with an outfit similar to the one used by Cushing. For the past 6 months a modified outfit has been used with satisfaction in this clinic, and a description of it may be of general interest.

A simple instrument has been devised which cuts the wire and at the same time punches out a clip (Fig. 1,B). No wire is wasted and a few feet will make a great number of clips. These clips are all uniform and can be quickly made without experience. The alternative method of making the clips by winding wire tightly on a diamond-shaped bar and then cutting along the sides with a special pair of scissors, was unsatisfactory; the sides of the clips were often of uneven length and the ends rough, and despite a great deal of care we have frequently had difficulty in using them efficiently.

A flattened wire has been more satisfactory than the round wire, as it overcomes the tendency of the clip to turn in the clip holder, and prevents the sides of the clip slipping past each other.

The magazine (Fig. 1,C) has been mounted on a heavy base, in such a manner that the covering can be gradually pulled out as the clips are

1A 1B 1C

Fig. 1. *A*, Clip holder; *B*, instrument for cutting wire and at same time punching out clip; *C*, magazine for storing clips. The arrow points to the wire.

Fig. 2. Method of using clip holder. It is possible for the operator to slide the holder down on top of a clip with one hand.

used. A fresh magazine can be quickly adjusted to the base. The spaces for the clip have all been carefully hand-made so that the ends of the clips reach to the bottom of each space.

The clip holder (Fig. 1,*A*) has been modified in two ways. A spring has been incorporated in the handle to keep the jaws apart, thus the holder is always ready for loading. The grooves for the clip on the inner surface of the jaws have been opened out to the tip; this enables one to slide the holder down on top of a clip with one hand (Fig. 2).

In the act of loading (Fig. 2), the holder is pushed over the clip to the base of the magazine, and as the ends of the clip rest against this base, the clip lodges at the very end of the holder. The procedure can be efficiently carried out with one hand because of the modifications to the holder and the heavy base on the magazine. With the Cushing outfit, two hands were necessary, and, unless a great deal of care were taken, one side of the clip would be touched first and loaded unevenly. Furthermore, the clip was never at the very end of the holder because the grooves were not open to the tip. The most important feature in having the groove on the inner side of the jaw open to the end is that it enables one to slide the holder down on top of the clip with one hand. Perfect clips, a carefully made magazine with a heavy base, and the spring on the holder, all add to the efficiency and speed of loading. When the clip holder is being used there is no tendency for the clip to spring out, even though it is lodged at the very tip. It was thought that the clip might break because of the flattened wire, but this has not been the case. Also there is no tendency for the clip to slip off when it has been closed on a blood vessel.

THE TREATMENT OF FRACTURES OF THE FINGERS AND METACARPALS WITH A DESCRIPTION OF THE AUTHORS' FINGER CALIPER

By HARRY E. MOCK, M.D., F.A.C.S., and JOHN D. ELLIS, M.D., Chicago

THE following observations of treatment of fractures of the long bones of the hand are offered as additions and amplifications of a former paper by one of the authors (7).

In the management of fractures of the fingers, we are presented with the same general problems that arise in connection with fractures of the long bones anywhere in the appendicular skeleton. However, since no fracture in the fingers can occur at a distance from the joint greater than 1 inch, we are also confronted with the problem of fractures in the vicinity of joints. In such cases the preservation and re-establishment of function is at least of equal importance to that of treatment of the fracture itself. Thus, one is confronted with the dual problem of treatment of the fracture and of preservation of joint function, not only in the involved finger but in the other fingers of the hand. The mechanical arrangement of the complicated set of tendons and their sheaths in the fingers is such that any good functional result is impossible without the almost complete restoration of the normal anatomical relations.

The report of the Fracture Committee of the British Medical Association[1] upon late results of fractures indicates that a good anatomical result and a good functional result are concomitant in over 90 per cent of 1,736 examined cases of fracture of all parts of the axial and appendicular skeleton. This report proposes as a dictum of surgery that "no method whether operative or non-operative which does not promise a good anatomical result should be accepted as a method of choice."

The traditional method of handling fractures contemplates a reduction by closed manipulation, the fragments being thereafter retained in position by immediate application of close-fitting rigid splints which immobilize the joint above and below the lesion. Since the late war experience, such a rationale of treatment has largely been abandoned in the case of fractures of the long bones except the phalanges. In surgical practice in most of the best hospitals, fractured fingers are treated by these time-honored methods.

[1] Report of the Committee on Treatment of Simple Fractures. Brit. M. J. 1912, November.

Large experience with fractures of the phalanges, both those handled by ourselves and those referred to us for reconstructive treatment for the re-establishment of function after the surgical care had been rendered by others, usually treated by the conservative method of reduction followed by immobilization, has convinced us: (1) that it is much easier to secure correct alignment of the fragments than it is to maintain such alignment by the application of retentive splints; (2), that the amount of manipulation of the injured finger necessary to secure reduction often produces tissue reactions which later result in very troublesome fibrosis in the joint capsules and ligaments and around the tendon sheaths; (3), that reduction and maintenance of fragments in alignment by continuous traction offers the advantages of lessening the severe trauma to the surrounding parts necessary in manipulation, prevents contractions of muscles, tendons, and ligaments which occur in the finger immobilized in splints, obviates the danger of harmful ischæmia produced by the pressure of splints, and keeps the joint capsules extended to the full limit, thus largely eliminating fibrous ankylosis of joints so commonly seen when this method is not employed.

These considerations of resulting function are more forcibly brought to the attention of the surgeon who is striving to secure the final end-result of functional restoration than to the one who is content to discharge his patient as soon as the bone injury has healed with instructions to start using the hand in the hope that function will gradually return. This constant supervision of the case until the patient actually goes back to work should be the duty of every surgeon interested in the complete rehabilitation of his patient. It represents the economic end-result which is an advanced step over the purely surgical end-result.

One of the most important of the newer methods of treating fractures is that of the application of direct skeletal traction by means of metal pins and calipers applied to the bones themselves. This direct skeletal traction may be utilized in fractures of the phalanges with the same decided advantages that have been noted when it is

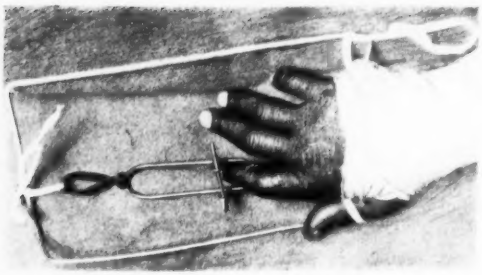

Fig. 1. Modified Walker splint with authors' finger calipers applied. Note traction by means of rubber band.

applied elsewhere. In fact we are convinced that it is the only method which will give the desired anatomical and functional result in those cases of very severe lacerations and contusions of the soft parts accompanied with one or more phalangeal fractures.

Fracture of the distal phalangeal bones, because of certain anatomical features, presents a clinical picture and a set of indications for treatment which are totally different from those of fractures of the other segments of the fingers.

FRACTURES OF THE TIPS

The distinctive features of the pathology of fractures of the tips of the fingers, the possible gravity, and the often prolonged course of these injuries, have only been appreciated since Kanavel (4) demonstrated that the pulp of the theca of the finger tip lies in a closed trabeculated connective tissue sac. This sac is least dense at the lateral borders of the ungual tuberosity of the phalangeal bone. This explains why the hæmorrhage which collects in the closed space after a fracture of the phalangeal bone so often escapes dorsally around the margins of the ungual tuberosity and forms a subungual hæmatoma.

Proximally this sac is limited by its attachment in the region of the insertion of the flexor pro-

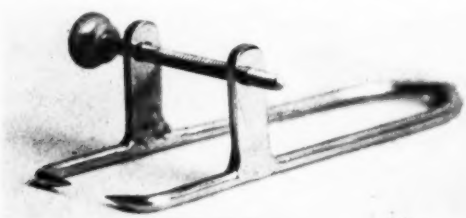

Fig. 3. Authors' metal finger caliper which can be applied to any phalanx or to the distal end of a metacarpal (Mock and Ellis).

Fig. 2. Method of applying extension through the finger nail.

fundus tendon. Distally it is attached to the margin of the broad irregular terminal expansion of the bone. The periosteum of the ungual tuberosity is so intimately connected with the bone surface that it is invariably torn when the bone is fractured so that subperiosteal hæmorrhage after fracture never occurs. The blood vessels to the diaphysis of this terminal phalangeal bone run parallel to its border on either side and within the closed fascial space and the nutrient foramina are on the flexor surface of the bone within this space.

Pathology. The hæmorrhage and œdema incident to fracture of the diaphysis, if it does not escape to the dorsum of the finger tip as above described, increases the pressure within the closed fascial space producing a tension capable of shutting off the blood supply to the diaphysis. Necrosis of the diaphysis may and often does result and this mechanism explains the frequent

Fig. 4. Banjo and Walker splints with finger calipers. The points are held in position in the cortex of the phalanx by means of a set screw.

necrosis of the entire diaphysis often seen developing several weeks after a simple chipping fracture here.

Moorehead (8) has described this mechanism plus supervening low-grade hæmatogenous infection of the accumulated blood and necrotic bone in this crowded space, as the pathogenetic factors of so-called "bone felon" which every surgeon has seen develop several weeks after closed fractures in the finger tips. Since this mechanism to produce tension and necrosis is not effective where laceration into the closed sac occurs, necrosis of the terminal phalangeal bone, osteomyelitis, and "bone felon" are much more frequent in closed fractures of the tip than those which are compound.

Madden (6) has called attention to this fact in his study of chip fractures of the finger tip, and every one with any experience in the surgery of trauma can verify this observation from his own experience.

Clinical course. In Hurley's (2) series of 27 cases of chip fracture of the tip occurring in steel mill employees, 1 lost 196 days from work, 17 lost approximately 60 days each, 9 not more than 3 days each. These figures indicate the economic importance of careful examination and prompt recognition of the surgical indications in the treatment of these conditions.

Treatment. On the first presentation of a crushed finger tip to the attention of the surgeon, an X-ray examination is imperative. Examination for crepitus is useless because the fragments are practically always separated. We found a separation of 1 millimeter or more in every case on checking up the X-rays of 30 consecutive tip fractures coming to our attention. In about 9 out of 10 of these cases in which a fracture is found, conservative treatment by immobilization is all that is necessary. In the remaining one, however, the following signs and symptoms develop within a few hours and become progressively worse: (1) swelling of the tip, (2) tenderness, and (3) throbbing pain.

Often the patient is unable to sleep the first night after the accident because of the throbbing pain. As has been pointed out, these symptoms do not occur in compound fractures or in those closed fractures accompanied by extensive laceration of the theca. This clinical picture presents an indication for immediate operation. This increasing tension in the finger must be immediately relieved. The site of the incision depends upon the location of the hæmorrhage.

If the hæmorrhage is subungual, a careful examination should be made to ascertain whether it is confined beneath the nail or has extended up under the eponychium. In the former case a chip is cut from the center of the fingernail with a straight knife, the edge of the blade being held almost parallel to the surface of the nail, and the knife drawn toward the tip of the nail. By this maneuver very little pressure need be exerted upon the very tender nail. This seems to us preferable to boring the nail, which is quite painful and provides for the escape of the blood only a tiny hole which is easily closed by coagulation or bits of fibrin and may have to be opened subsequently. The approach to the nail bed by incision beneath the free edge of the nail is objectionable both because of the extreme sensitiveness of this region, and because it cannot be thoroughly sterilized, the epidermis being often fissured and irregular where it is attached to the nail. If the hæmorrhage is principally beneath the lunula or proximal to this under the perionychium, it can be liberated by separating this structure from the eponychium with a sharp knife.

If the hæmorrhage does not appear under the nail, an "alligator mouth" incision should be made through the theca by a careful dissection with a Graefe cataract knife ⅛ of an inch below the nail through the tip and including the full width of the finger backward until the site of the injury is exposed.

Although, as Jones (3) points out, the hyponychium is peculiarly resistant to infection, yet the rough and thickened skin of the fingers of working men presents a contaminated field. Careful surgical preparation of the finger before operation is essential. One may use full strength tincture of iodine followed by alcohol. Excessive grease and oily dirt can be removed with ether or, as we prefer, any commercial carbon tetrachloride, "cleaning fluid." No anæsthetic is required for the incisions about the nail. Because we have felt that the swelling of the finger often resulting from the injection of a local anæsthetic might contribute to a passive congestion, which we were trying to relieve, we have routinely employed gas and more recently ethylene in inducing general anæsthesia for incisions of fingers.

Another type of chip fracture in which operation is indicated is the one which, although presenting no unusual symptoms at first and no sign of increasing tension, remains tender. Roentgenograms must be made at frequent intervals. If the tenderness persists after 2 or 3 weeks, it will be found in the roentgenograms that the fragments are becoming smaller and show signs of necrosis instead of bone proliferation. It is

evident that the blood supply to the fragment from its periosteum is not sufficient for bone proliferation to occur. The removal of such fragments through a small incision in the tip is indicated. No curettement should be done, as it is important not to injure any normal periosteum of the diaphysis which may remain. We have a large number of cases which show regeneration of the entire distal phalanx from shreds of periosteum left behind after the diseased bone had been removed.

FRACTURES OF THE SHAFTS OF THE PHALANGES AND METACARPALS

Fractures of the shafts of the phalanges and metacarpals present all the varieties and complications found in fractures of the long bones. Treatment depends upon: (1) displacement and comminution, (2) joint involvement or complicating dislocations, (3) concomitant injuries of the soft parts.

Simple transverse fractures and others without displacement or joint involvement need only immobilization on a palmar or dorsal splint for 2 or 3 weeks with daily manipulation and passive motion of nearby joints, the progress of callus formation being checked occasionally by roentgenograms. In the metacarpus such simple fractures are similarly treated with the fingers immobilized in flexion around a bandage roll or padded wooden ball.

When displacement, comminution, or joint involvement exists, extension is necessary, the choice of method depending on the condition of the adjacent soft parts. A banjo splint with either plaster wrist band or aluminum forearm splint or a Walker splint (Fig. 1) to which a wire frame has been attached is applied and from this, extension is made upon the finger with rubber bands or a small coil spring which can be attached to the finger by moleskin adhesive strips or Wheeler's (13) or Sinclair's (10) glue or gauze strips.

Vallet (12) has devised an extension apparatus for transverse fractures of the phalanges with angulation which comprises a flat aluminum splint like a tongue blade which can be angulated in the region of the fracture to secure correction of the deformity and a sliding metal piece with hooks fitting over the webs between the fingers, against which counter traction is made. This, like the wire splint described by Wilson and Cochrane (14) is suitable for simple fractures of the middle and proximal phalanges of the second and third fingers which have a web on either side of the base.

We have, for most purposes, discarded the use of adhesive and glue, and employ finger-nail extension which obviates the slipping of adhesive, blistering, or desquamation of the skin often resulting from glue. This is applied by boring two holes in the free margin of the finger-nail with a sharp pointed knife (Fig. 2). If the free margin of the nail is not long enough, the skin can be pushed back under local anæsthesia, a procedure which is entirely painless. Through these holes in the nail margin small silk ligatures or malleable wire is introduced, and this is attached to the rubber band. Extension can be made in this manner without injury to the nail. Occasionally the nail moves forward about $\frac{1}{8}$ inch so that the lunula increases in depth, but after extension is removed, the normal contour of the nail is re-established. Such extension on the nail, because of the intimate connection between the hyponychium and periosteum of the distal phalanx, practically constitutes direct skeletal traction and considerable force can be applied. We have used as much as 8 ounces of traction. This nail extension also allows the application of Dakin's solution to open wounds and can be used also in cases of swelling and contusion of the finger where adhesive or glue would not adhere or is contra-indicated. This type of extension, however, is not forcible enough to overcome any considerable over-riding or to prevent shortening in case of marked comminution such as those seen in severe crushing injuries of phalanges and metacarpals and where more powerful extension is indicated or where considerable torsion is necessary to coapt spiral fractures. In these, either the Steinmann nail or the finger calipers must be applied.

To Schum (9) belongs credit for the first use of the Steinmann nail in fractures of the hand. In his capacity as director of surgery for the police of the City of Berlin, Schum has had a wide experience with severe hand injuries, including many compound and shattered fractures of the metacarpals. He reports 50 cases in which a Steinmann nail was applied, but does not describe his technique. He applies extension to the nail by the use of a banjo splint with cross bars which are useful in case torsion is necessary to bring the fragments in alignment. He rarely leaves this extension on longer than 2 or 3 weeks, as sufficiently firm union has taken place by that time.

FINGER CALIPER

For the same type of injury for which the Steinmann nail is employed, we are now using a special type of caliper which we have devised.

This consists of a U-shaped bar approximately 5 inches long, 1½ inches wide and ⅛ inch in diameter, hinged at the apex, with the free ends tapered and turned in at right angles toward each other. The points are held in position in the cortex of the phalanx by means of a set screw passing through two flat strips arising from the sides of the splint (Figs. 3 and 4). The technique for the application of these is very similar to that of the Steinmann nail. In our experience the Steinmann nail produces more tissue reaction and involves more danger of fracture of the phalanx in its application than do these calipers. In this connection there are several anatomical considerations of importance. The shafts of the phalanges are, of course, not round but flattened, especially the proximal one on the sides of which flanges are developed for the attachment of the lumbrical and the interosseous muscles. In muscular subjects, these phalanges are quite flat. It is not necessary or even advisable to apply the nail or caliper to the injured phalanx, as by the application of skeletal traction to the phalanx distal to the injured one, full extension of the intervening joint capsule can be maintained and at the same time traction of the fractured fragment secured.

In fractures of the metacarpals, extension is applied to the proximal phalanx, and the best location for its application is the neck of this bone just proximal to the capsular ligament. The bone is free in this region, while the more proximal parts of the lateral surface are covered by the ligaments of the lumbricales and the interosseous muscles. In order to avoid the extensor tendon sheaths which extend further around the phalanx than those of the flexor tendons, incisions are made about ⅛ inch volar to the lateral margin of the bone. A small knife is introduced and the extensor tendon sheaths pushed back without being opened. Incision of the skin should be about ¼ inch in length and extend distal to the point where the extension is to be applied so that there will be no tension on the skin by the point of the calipers or the nail which should be situated at the proximal end of the incision. The periosteum is pushed back with the end of the knife. These incisions can be made under local anæsthesia. The points of the caliper are screwed firmly into the bone, or if a nail is used, a $\frac{1}{32}$ inch drill is passed through the neck of the bone and an ordinary Glover's needle, such as is used in suturing the skin, inserted and broken off so as to extend ¼ inch beyond the skin on either side. The needle is secured in position by a silk suture passed through the eye and tied around the finger. Narrow strips of gauze soaked in compound tincture of benzoin are used to seal the wounds and wrapped around the needle or the caliper where this passes through the skin incision.

Some particular types of fracture require special types of treatment. In drop finger, or mallet finger, the insertion of the extensor is torn off by the avulsion of a small flake of bone at the insertion of this tendon into the dorsum of the base of the distal phalanx. This is generally sustained by violence applied to the tip of the partially flexed digit. It is imperative that the distal phalanx be brought into perfect apposition with the avulsed fragment. This can generally be accomplished by splinting the finger with the distal interphalangeal joint in sharp hyperextension, as described by Bainbridge (1) and Laird (5). If the X-rays do not reveal perfect apposition, open operation or subcutaneous operation with the insertion of needles as described by Tennant (11) must be performed. The finger should be left immobilized for 3 weeks, after which careful passive motion is instituted.

Bennet's fracture of the base of the first metacarpal is usually produced by force transmitted through the bones of the thumb. The fracture line is oblique and the fragment may consist of either the dorsal or volar portion of the base. This fragment cannot be controlled and after manipulation reduction tends to slip out again. We find that powerful traction on the thumb, generally applied by means of calipers, accompanied by either flexion or extension depending on the position of the proximal fragment, will accomplish and maintain reduction.

Non-union of fractures of the long bones of the hand are fortunately uncommon. The introduction of foreign bodies into the hand in these cases is seldom, if ever, advisable. We have secured very satisfactory results by applying strips of periosteum around the ununited ends after freshening them.

Fractures resulting from bullet wounds are often accompanied by considerable comminution and require caliper traction after debridement has been done and the Carrel method of wound sterilization instituted.

CONCLUSIONS

1. Traction without injurious manipulation and splinting will often reduce and maintain reduction in fractures of the long bones of the hand.

2. Direct skeletal traction is applicable to these fractures and is the indicated method in cases in which other traction cannot be applied.

3. Skeletal traction, especially by the finger calipers designed by the authors, has given the best functional end-results in cases of severe trauma of the soft tissues concomitant with phalangeal fractures.

4. Due to the proximity of joints in all finger fractures constant attention must be given to the preservation of joint function.

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AN OPERATION FOR STERILITY IN THE MALE[1]

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BILATERAL epididymitis is the most frequent cause of obstructive sterility in the male. Strictures of the vasa deferentia and ejaculatory ducts are also etiological factors. Various procedures have been recommended and employed for restoring the continuity of the seminal duct. Practically all consist in short-circuiting the vas deferens for a block at the tail of the epididymis and resection and reunion of the strictured vas.

Successful end-results have, however, been so few that the patient can entertain very little hope for a renewed fertility. The Martin operation of vaso-epididymostomy (15) and its various modifications—a procedure most frequently employed—with few exceptions (Hagner, 11), has given no more than 10 per cent successful results.

Because of the large number of failures, some men have abandoned all attempts toward restoring the continuity of the duct and recommend puncture of the testicle or epididymis and aspiration, and artificial impregnation (Posner, 21). Lespinasse's artificial spermatocele sac (12) was for the purpose of accumulating a large quantity of semen to be deposited in the same manner.

Strictures of the ejaculatory ducts. Permanent occlusion of the ejaculatory duct is rare. Temporary blocking due to plugs of mucus or pus, or œdema and distortion of the verumontanum is quite common. When stricture is found, dilatation through the endoscope (5) may be possible. Most attempts at dilatation are unsuccessful.

Strictures of the pelvic portion of the vas deferens. These are, fortunately, quite rare, having been found in about 1 per cent of vasotomies (Belfield, 2). Repair of these strictures is practically impossible because of their inaccessible location. Boari (3) united the vas to the anterior urethra and recommended this method for the relief of strictures of the pelvic vas and the ejaculatory ducts.

Strictures of the scrotal portion of the vas deferens. These include all strictures of the vas up to the external inguinal ring and for a few inches beyond, for the redundancy of the vas deferens allows it to be pulled out for some distance. Strictures of this portion of the vas deferens are quite common.

They are frequently present in association with an epididymitis and must be removed before any attempt is made at short-circuit of the vas. They are also frequently found without an epididymitis—these are usually unilateral—and may be analogous to strictures of the lower portion of the ureter. They may also be due to trauma or injection of strong irritants in vasotomy.

This is an accessible portion of the vas deferens and strictures in this region can be readily and successfully repaired in the majority of cases. Resection of the strictured portion and end-to-end anastomosis, with a silkworm suture in the lumen coming out through the skin to act as a splint and to direct epithelization, has proved successful in many cases. Successful results with this and other procedures, both clinical and experimental, in restoring the patency of the vas have been reported by Mayo (16), Lydston (14), Christian and Sanderson (5), Pignatti (20), Wheeler (27), Schmerz (25), Seyberth (26), Gohrbandt (7), and others.

Vas-epididymostomy, union of the vas deferens to the epididymis above the obstruction, and vaso-orchiostomy, union of the vas to the rete testis, are the procedures employed for the relief of the occluded epididymis.

VASO-EPIDIDYMOSTOMY

Martin's original operation was a lateral anastomosis of the vas to the head of the epididymis with catgut sutures, the operation being entirely extravaginal. Since then, various modifications in the suture material used and in the choice of the point of attachment to the epididymis have been reported by Fuller (6), Hagner (10), Quinby (22), and others.

Silk, human hair, and silver wire for suture, and the placing of the sutures to produce a circular anastomotic channel, are some of the variations from the original. End anastomosis of the vas to the epididymis (Hagner, 8) and union of one vas to the epididymis of the other side (Hagner, 9) have been reported. Bogoljuboff (4) reported a series of experiments in which he resected the tail of the epididymis and implanted or united the cut end of the vas to the epididymis with a few successful results.

The reasons for the relatively few successes in vas-epididymostomy may be summarized. Some are well recognized and others not generally considered or understood.

[1]Presented before the Chicago Urological Society, November 23, 1926.

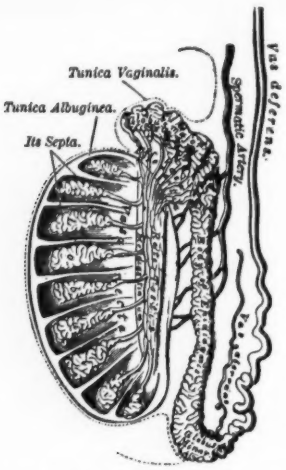

Fig. 1. Cut from Gray's Anatomy showing particularly the rete testis and epididymis.

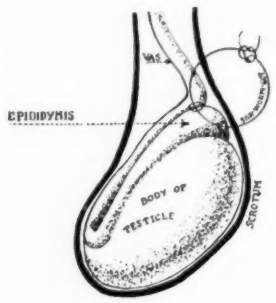

Fig. 2.

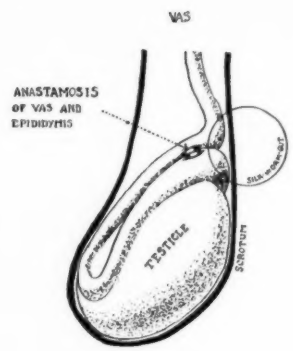

Fig. 3.

Fig. 2. Diagrammatic sketch showing lateral anastomosis of the vas to the head of the epididymis with a silkworm through the point of anastomosis coming out through the vas and epididymis and tied on the skin, as described by McKenna. The silkworm is intended to prevent blood clot from organizing and closing the anastomotic channel.

Fig. 3. Diagrammatic sketch similar to Figure 2 except that the silkworm is run through the epididymis above the point of anastomosis to prevent movement of the vas and tension at the point of anastomosis. (Author's modification.)

1. Vaso-epididymostomy is not a direct anastomosis. A cup-shaped piece of tubule of epididymis is removed in the hope that anastomosis will develop from one of the convolutions. Direct vaso-epididymostomy (Lespinasse, 13) is rarely possible because of the almost microscopic size of the tubule of the epididymis above the tail.

2. Slight hæmorrhage with a blood clot at the point of anastomosis, trauma of the operation, and the irritation by the suture material can produce enough scar tissue to occlude the anastomotic channel. McKenna (17) recommended a procedure which he modified later (18), for the purpose of preventing clots from organizing and closing the point of anastomosis, as shown in Figure 2, and reported some success. It consists in the insertion of a silkworm-gut as a retention suture through the vas, through the point of anastomosis and through the epididymis, united on the skin of the scrotum and left in place 5 to 7 or 10 days.

3. The epididymis tubule is very thin and as friable as tissue paper. Any suture material will tear through readily and particularly so as a result of the œdema following the trauma of the operation. Even though the point of anastomosis be in the intravaginal portion of the epididymis, union will not be very firm, for the tunica vaginalis covering the epididymis is much thinner than that covering the testicle (Morris, 19).

4. The testicle moves up and down with the contraction and relaxation of cremasteric and dartos, and the vas deferens which is redundant and also has some elasticity and peristaltic action, tightens, takes up slack, and loosens with the movements of the testicle and with filling and emptying of the bladder. Because of these factors there is always considerable tension at the point of anastomosis, with a resulting separation of the apposed tubules. This is probably the most important cause for failure of the operation.

I have recently had a successful result in which an attempt was made to limit the mobility of the testicle and vas, as shown in Figure 3. A silkworm-gut was run through the vas and epididymis, as in the procedure recommended by McKenna, except that the silkworm emerged from the vas above the point of anastomosis, then through the epididymis above the point of anastomosis and out through the skin.

5. It may be well to note when a successful result is obtained with any of the procedures mentioned or any of the others to be discussed, that the new anastomotic channel may become gradually occluded by contraction of scar tissue about it or within its lumen, so that one cannot speak of permanent results.

UNION OF VAS DEFERENS TO SPERMATOCELE

Spermatoceles are common and may be present coincidentally with occlusion of the epididymis. Lateral anastomosis or implantation of the cut end of the vas into the sac, as shown in Figure

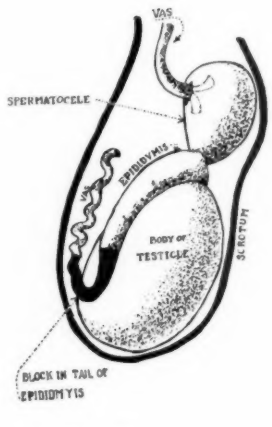

Fig. 4.

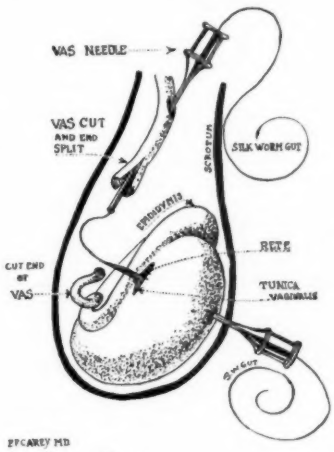

Fig. 5.

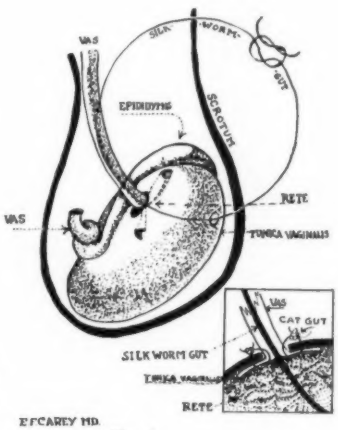

Fig. 6.

Fig. 4. Vas implanted into spermatocele when it is coincidentally present for a block in the epididymis. Diagrammatic representation of an operation that should offer excellent possibilities for success.

Fig. 5. Author's operation—union of vas to rete testis with a silkworm through testicle and point of anastomosis. Diagrammatic sketch showing the various steps of the operation as described in the detail of the operation. The needles in the vas and that through the testicle are threaded with the silkworm and then removed. Sutures are placed in the split end of the vas and united to the tunica vaginalis at the rete.

Fig. 6. Operation completed. Vas is united to rete testis and the silkworm running through vas and testicle is tied on skin of scrotum and left in place 7 to 10 days before removal.

Lower inset shows end of vas spread out and dipped into rete and united with catgut to tunica.

4, offers excellent possibilities for success. Hagner (11) has reported a successful case. Attempts to produce true spermatocele experimentally for the purpose of having a sac to which the vas could be attached have been entirely unsuccessful (23).

UNION OF THE VAS DEFERENS TO THE RETE TESTIS

The rete testis is an intercommunicating network of tubules located in the mediastinum of the testicle, whose function is similar to that of the renal pelvis, the sperm accumulating in the rete and passing out into the efferent ducts. The vasa efferentia and the rest of the seminal duct are developed from the wolffian body and wolffian duct, whereas the rete develops from the genital gland (Wilson, 28). In some lower vertebrates living in water and in many invertebrates, the duct system does not exist; the sperm is expelled from the rete into the peritoneal cavity, as is the ovum of the human female, and then out through pores in the lower abdomen.

The testicle has a thick tunica vaginalis and also a tunica albuginea and vasculosa, so that sutures inserted through its coverings have an excellent chance of remaining in place. The rete testis, consisting of many tubules, should, theoretically at least, offer better opportunities for anastomosis than the single tubule of the epididymis.

Union of the vas to the rete was first done experimentally by Scaduto (24), who resected the epididymis and united the cut end of the vas to the rete. None of his operations were successful. Bogoljuboff (4) reported a few successes and since then various authors, mostly foreign, have reported varying degrees of success and failure with this procedure.

AUTHOR'S OPERATION

The operation that will be described consists in the union of the vas to the rete with the addition of a silkworm gut running through the vas and testicle at the point of anastomosis and tied outside on the skin of the scrotum. The purpose of the silkworm gut is to develop a patent channel, to prevent organization of a scar and to make a path for epithelization. It furthermore fixes the testicle and vas quite well, preventing their mobility and preventing tension at the point of anastomosis.

The chief objection to this procedure is the possible injury to the testicle from the silkworm that is run through it and allowed to remain in

place a number of days. Section of the testicle in all the fourteen operations on dogs in which the suture remained in place for periods varying from 2 to 14 days was done to determine the extent of injury to the testicle.

No evidence of scar was to be found, the point of exit of the silkworm on the convex surface of the testicle could not be located and except for the destruction of a few tubules along the course of the silkworm, apparently no injury to the testicular tissue resulted from this procedure.

In none of the 14 operations was an animal infected, despite the constant gnawing and sawing away at the retention suture by the dogs. In 8 the silkworm was pulled out prematurely. In another series of experiments in which the cut end of the vas was united to the head of the epididymis with silkworm left in place as in the McKenna operation, all the dogs became infected or developed a localized epididymitis from the constant pulling at the suture. It is evident therefore that the testicle withstands considerable trauma and is quite resistant to infection.

Of the 14 bilateral operations on 7 dogs, only 6 can be reported for the silkworm was pulled out before the fifth day in the other 8. Of the 6 in which the silkworm remained in place 7 to 14 days, 2 were successful. Sperm could be squeezed out from the testicle through the vas in these 2 cases.

This procedure appears to be rational, and with improvement in technique should give an appreciable number of successful results on the human where the sutures will remain undisturbed. I have recently performed this operation on one man but cannot determine the end-result for I have lost track of him. In this case also, except for the immediate reaction during the first few days, there was no gross evidence of injury to the testicle.

DETAIL OF THE OPERATION

The detail of the operation is shown in Figures 5 and 6. The vas deferens is lifted out of its sheath about 1½ inches above the point where it crosses the mediastinum of the testicle. A small longitudinal nick is made in it and the vas catheterized toward the posterior urethra to determine its patency, or colored fluid is injected for the same purpose, as should be done in all operations for obstructive sterility. A blunt vasotomy needle is inserted downward toward the epididymis through the opening in the vas and the vas then divided over the needle at the point where it crosses the mediastinum of the testicle. The upper end of the vas is split in two or three parts and 000 catgut sutures inserted through the split ends with a No. 23 gauge hypodermic needle. All the suturing and running through of the silkworm is done with hypodermic needles as in the fine blood vessel and vas anastomosis recommended by Belfield (1). The vasotomy needle in the vas is threaded with a fine silkworm and then removed.

A long No. 23 gauge needle is inserted through the posterior convex surface of the testicle with its point emerging at the rete in the mediastinum. At this point of emergence, the tunica is split for a distance of one-fourth of an inch and the rete incised. A slide is taken now or preferably beforehand from the incised rete to determine the presence of sperm, as is done in all operations from the point where the anastomosis is to be made. The needle running through the testicle is threaded with the silkworm in the vas and withdrawn, so that the silkworm is now through the testicle and vas. The sutures in the split end of the vas are united to the tunica of the testicle which has been incised and the ends of the vas dipped somewhat into the rete and the sutures then tied. The silkworm is carried out on the skin on both sides and then tied. It is left in place 7 to 10 days before removal.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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OCTOBER, 1927

PRESENT DAY REQUIREMENTS IN ANÆSTHESIA

THE patient of today is no longer satisfied merely to be spared pain during operation. He may demand a local or a general anæsthetic. Those who seek unconsciousness complain unless induction and recovery are as short and as pleasant as possible. If local methods of inducing anæsthesia fail or are not available, disappointment may be keen. The surgeon requires of the anæsthetist that the operative field be quiet and relaxed for the use of either cautery or knife. Both patient and surgeon demand that the anæsthesia shall be as free as possible from immediate and remote dangers and complications.

The environments and the many diseases complicating the life of man have produced grave risks which many times challenge the best efforts not only of the surgeon but of the anæsthetist. As surgeons gain confidence in themselves and in their associates, more cases entailing grave risks are brought to the operating room. Thus to the demands of the surgeon and the average patient are added those of a body racked by disease. If any of these demands are ignored, satisfactory results are difficult to obtain. Even the skilled surgeon often secures with difficulty some of the splendid results accomplished by modern surgery, unless the operative field is quiet and relaxed, as well as sterile and insensitive.

The anæsthetist administering chloroform was so successful in meeting most of these demands that many years elapsed after the dangers of this type of anæsthetic were well known before surgeon and anæsthetist were willing to forego its benefits. But gradually the use of ether by the open-drop method became almost universal. The relaxation was usually sufficient, but the operative field was not quiet because of uneven or labored respiration except in deep anæsthesia. Some unpleasant postoperative effects, chiefly nausea and vomiting, made some patients dread ether anæsthesia more than the operation.

The surgeon's dread of chloroform and the patient's distaste for ether grew apace, so that it was not surprising that gaseous and local anæsthetic agents, primarily advocated especially when the surgical risk was grave, were more or less successfully applied when the risk was not serious. As a result almost every type of operation was performed by the aid of, or in spite of, any one of a number of anæsthetic agents. In the last few years anæsthetists have gradually adjusted themselves to the advantages of the older and newer methods, so that now there is a tendency to use those agents which, alone or in combination, provide quiet and relaxation without untoward effect postoperatively. This is especially noticeable whenever the surgeon

encourages the anæsthetist to become proficient in the use of many anæsthetic agents and in more than one way of employing each. It is quite likely in the future development of anæsthesia that more and more emphasis will be placed on relaxation, and the anæsthetist's popularity will depend on his ability to supply such relaxation without adding avoidable elements of danger or unpleasantness.

The quest for such a technique, which adds the desirable results of chloroform to the relative safety of ether, is gradually carrying us away from deep anæsthesia by inhalation methods alone. Morphine and oil-ether colonic anæsthesia provides quiet respiration and relaxation and in skilled hands is apparently safe, but the method is obviously open to improvement. Fortunately improvements are being constantly made in its use.

Sacral-block anæsthesia is so satisfactory for excision of hæmorrhoids that, when properly applied, it is the most finished work of the present day anæsthetist and has satisfied both patient and surgeon.

Methods of inducing local anæsthesia for operations in many parts of the body have often been unsatisfactory unless combined with morphine pre-operatively and light general anæsthesia. The absence of periods of cyanosis and straining has been particularly noticeable in necessarily light general anæsthesia when carbon dioxide has been available. The extensive use of carbon dioxide is recent, and its place in anæsthesia technique is debated.

Certainly there is no ideal routine anæsthetic agent in general use at the present time, although almost any operation may be painlessly performed by the use of any one of a dozen or more anæsthetic agents. Organic chemists have been unusually successful in synthesizing new agents which are capable of producing local anæsthesia. A great deal of progress in the future may be expected from such efforts. The time may come when safe general anæsthesia and muscular relaxation can be produced by agents injected hypodermically. At the present time the greatest promise of progress is held out by a more and more careful application of the known anæsthetic agent or agents best suited to the patient and his peculiar physical condition; there is little place for routine in anæsthesia.

JOHN S. LUNDY.

PHYSICS AND THE PHYSICIAN

PREMEDICAL students often lose sight of the fact that the term physician was probably originally applied to the man who treats bodily ills, because of his acknowledged familiarity with certain laws of nature; they may have overlooked the significance of its origin from the Greek word meaning nature. Students are likely to feel that physics is a science (to which is appended a number of necessary credits toward graduation) and that the particular division called mechanics is important only for students of engineering.

On the contrary, an understanding of the fundamental laws of mechanics is essential to the creditable treatment of the injuries of the back and extremities. The shipwrecks that at times drift into the care of the orthopedic surgeon indicate either that not everyone is fitted by nature to deal with mechanical problems or else that the training of certain practitioners has been inadequate. For instance many cases of non-union following fracture of the humerus are seen that have been obviously inefficiently treated by a cast extending only from the wrist to the axilla instead of from the wrist over the arm and body to immobilize not only the elbow but also the shoulder joint. Again, the ever-present ischæmic contrac-

tures, following fracture of the leg as well as of the arm, are a gloomy reminder of an inadequate appreciation of the mechanics of circulation as well as of the mechanics of bone and muscle. Looking on the brighter side, some of the best work in the treatment of the injured has been done by the practitioner working alone, meeting the needs of his patients with a good supply of ready knowledge combined with common sense. Hugh Owen Thomas was such a man, working in his own way, hammering out his own splints for the many traumatic cases that came to him from the docks of Liverpool; he gave excellent service to his patients and left us the heritage of many useful appliances. Among these is the Thomas caliper splint which is now used in so many ways for disabilities of the lower extremity.

An important part of modern industrial and traumatic surgery is the treatment of fractures. Questions are often asked about the proper treatment of fractures of the humerus, femur and other bones. It is not well to outline many iron-clad rules for all fractures, for fractures even in the same region of a bone often vary considerably. It is well to be familiar with the various appliances used, but it is better to consider each case an independent problem and to attempt to satisfy the demands of the basic mechanical laws governing the situation. For the reduction of the fracture itself some understanding of the laws of force and the laws of fulcrums and levers is essential. In maintaining the reduction, vigilance is necessary to insure that the retentive apparatus is actually functioning.

Laws of nature that may be expressed in formulas are likely to frighten us. In fact, however, formulas simplify the matter by expressing a law in terms that are universally applicable. Complex as some problems in physics become, it is fortunate for us that the laws which we need most are as simple as they are important.

The importance of proper mechanics in reconstructive surgery is nowhere more aptly summarized than by Hippocrates[1] in describing a splint which he used for fractures of the leg. He wrote: "If . . . properly managed, . . . this is an excellent contrivance; but if any of them (parts of the splint) do not fit properly, it does more harm than good. And all other mechanical contrivances should either be properly done, or not be had recourse to at all, for it is a disgraceful and awkward thing to use mechanical means in an unmechanical way." HUGH T. JONES.

[1]The Genuine Works of Hippocrates, translated from the Greek by Francis Adams, LL.D. Printed for the Sydenham Society, London, 1849, vol. ii, p. 539.

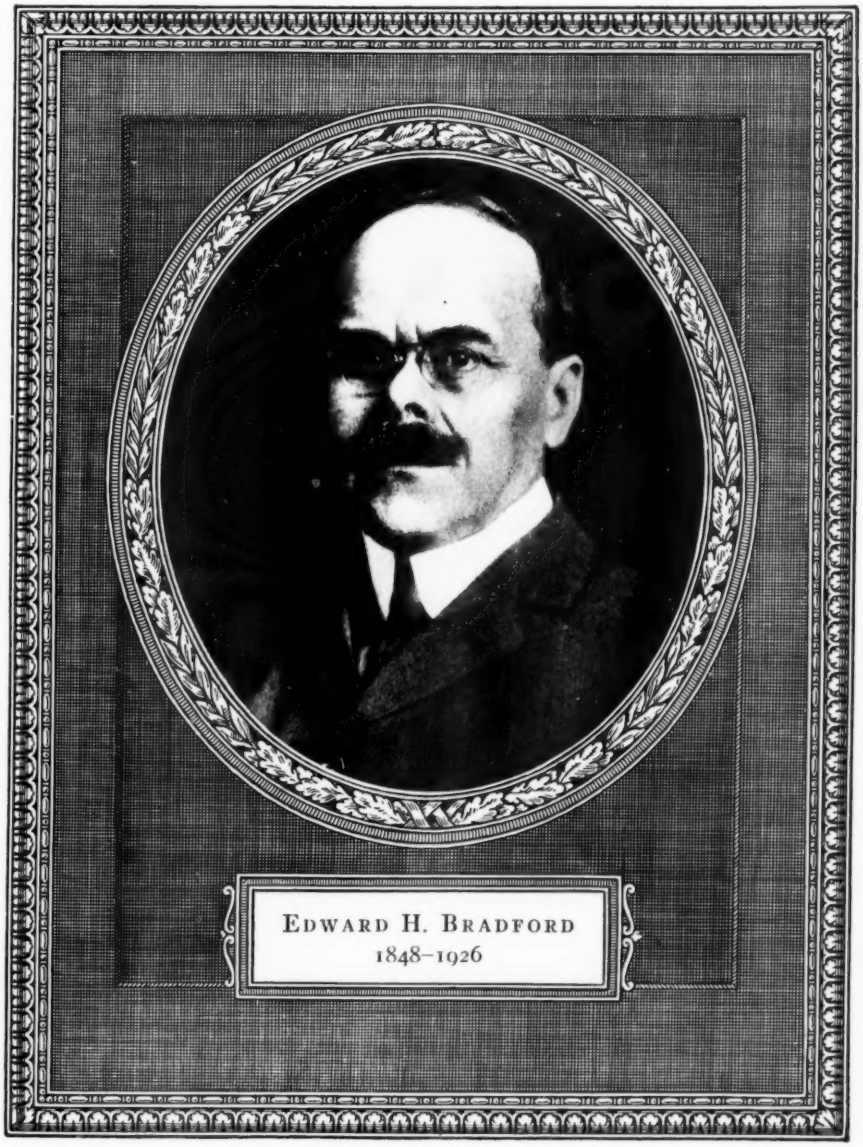
MASTER SURGEONS OF AMERICA

EDWARD HICKLING BRADFORD

DR. BRADFORD was a prominent figure in the group of Boston surgeons during the last part of the nineteenth century and the early part of the twentieth. While he always maintained a lively interest in general surgery, and held, at times, a number of positions which required much purely surgical work, his special concern and his principal activities lay along the lines of orthopedic surgery, in which specialty he was one of the outstanding pioneers in America.

He was born in Boston, June 9, 1848, being descended from old New England stock—an early governor of the State being one of his direct ancestors. After a preliminary education in the preparatory schools, he entered Harvard College, and graduated in 1869. He then began his medical education at the Harvard Medical School, where he graduated in 1873, receiving the degree of M.D. Crossing, then, to Europe, he passed two years in visiting the various medical centers, where he attended lectures and clinics. While in England he worked many months with Dr. Owen Thomas, of Liverpool, a pioneer in joint surgery, and the inventor of the splint called after his name. Upon his return to America, he went to New York, and there followed the surgical work of Dr. Charles Fayette Taylor. Finally he came back to Boston, where he established himself, and began the practice of his profession.

For a long period he worked with Dr. Buckminster Brown at the House of the Good Samaritan. This institution was the first one in Boston where the bone and joint diseases of children were regarded as belonging to a special branch of surgery, and where, as such, they were carefully studied and treated. In course of time Dr. Bradford succeeded Dr. Brown as surgeon in charge of this institution. Early in his career, he was invited to join the surgical department of the Boston City Hospital, and of the Boston Dispensary, and also that of the Children's Hospital, at all of which institutions he worked hard and faithfully for many years, gaining much valuable experience, and being gradually promoted from one grade to another until in all of them he reached the highest position. As time went on, he devoted more and more of his attention and energies to orthopedic surgery; and for this reason he became more and more closely associated with the Children's Hospital; and, it was largely here that he thought out and made known the correct pathology of congenital dislocation of the hip, and later



EDWARD H. BRADFORD
1848–1926

instituted the proper methods for its treatment. He also invented, for the treatment of Pott's disease, the simple and useful frame which ever since then has borne his name. Of the many other pieces of orthopedic apparatus brought out by him may be mentioned the Bradford abduction hip-splint, which has been very successfully used in the ambulatory treatment of caries of the hip joint.

In 1880, he joined the surgical department of the Harvard Medical School, with the title of clinical instructor of orthopedic surgery; and he was gradually promoted until, in 1903, he was made full professor, being the first person to hold the Buckminster Brown professorship of orthopedic surgery. He retained this position until 1912, and, during this long time (1880–1912), except for a brief period, he gave much of his time and attention to teaching. In this he was very practical, and he believed emphatically in the use of models and illustrations of all kinds to make clear his points. In the course of his teaching, he used a very large collection of lantern slides, a collection which he himself had made, and which he later presented to the School. In 1912 he was made Dean of the School, and he discharged the duties of this office for six years. During this time, and in fact for the rest of his life, he was greatly interested in the welfare of the students, with whom he tried always to keep in very close personal touch. To use the words of President Lowell: "He gave a new birth to orthopedic surgery in this country, and his administration as Dean prepared the way for the developments of the School that have since taken place." In 1919, he was elected an overseer of Harvard College, and his interest in the College and the School never abated. The Board of Overseers of the College voted, some weeks previous to his death, to confer upon him the degree of doctor of science (S.D.) and this decision was announced by President Lowell at Commencement, June 24, 1926.

He belonged to a number of professional societies, national as well as local, and he was constant in his attendance at meetings, he himself making frequent contributions. His book on *Orthopedic Surgery*, which, with the late Dr. Robert W. Lovett, he published after his many years of rich experience, marked a distinct epoch in the development of the specialty of which it treated; and it went through five editions.

Although most of his time was passed in attending to his work at the hospitals and at the medical school, as well as to his own private practice, an extensive one, he found opportunity also for other activities, for he was president of the trustees of the Massachusetts Eye and Ear Infirmary, chairman of the board of trustees of the Massachusetts Hospital School (Canton, Massachusetts), a trustee of the School for Crippled and Deformed Children, a trustee of Simmons College from the time of its inception, and a trustee of the Boston Library Association, an institution founded in 1791.

During the Spanish War, and also during the World War, he offered his services to the Government, and as they were accepted, he did for the country

during those trying times much professional and semi-professional work, which was of distinct value.

All these activities were pursued in spite of gradually increasing impairment of vision, the result of an injury received from an accident in middle life. Toward the end of his life he took up the study of Braille, in order to keep himself in touch with the outside world. He studied hard, became very proficient in its use, and derived much pleasure from it.

Dr. Bradford died suddenly of cerebral hæmorrhage on May 7, 1926, in his seventy-eighth year. Funeral services, conducted by his lifelong friend and classmate, Rev. Francis G. Peabody, were held in Appleton Chapel in Cambridge (the Chapel of Harvard College), where he had worshipped all his life; and Dr. Peabody's eulogy in memory of Dr. Bradford was eloquent and touching. Obituary notices appeared in many periodicals in this country and abroad. The *British Medical Journal*, among others, gave a full account of Dr. Bradford's life and works, and referred to his loss as that of "a notable figure from the dwindling group of pioneers of orthopedic surgery."

In the high-grade work that Dr. Bradford, by his intelligence, ingenuity, and persistent labor, has done, he has made a very generous contribution to the world, as indeed all those who are in a position to know fully appreciate.

Besides this, he was a man of culture. He was very fond of art, and was familiar with the best works of painting, sculpture, and architecture both here and abroad. Few men, moreover, have been so beloved by their fellows as he was, for his modest and kindly nature, combined with his courage and his insistent desire to help others, attracted the attention and admiration of all who knew him. To them the thought of Dr. Bradford's life and accomplishments, but, above all, the remembrance of his personality, will always be a source of pleasure and of inspiration.

GEORGE H. MONKS.

TRANSACTIONS OF SOCIETIES

CHICAGO GYNECOLOGICAL SOCIETY

REGULAR MEETING, DECEMBER 17, 1926, DR. W. A. NEWMAN DORLAND, PRESIDING

THE LOCAL USE OF ETHER IN GYNECOLOGY

DR. GEORGE DETARNOWSKY read a paper entitled "The Local Use of Ether in Gynecology."

THE ORTHOPEDIC ASPECT OF LOW-BACK PAIN IN CONNECTION WITH PELVIC DISORDER

DR. PHILIP H. KRUESCHER (by invitation) read a paper on "The Orthopedic Aspect of Low-Back Pain in Connection with Pelvic Disorder" (See p. 482).

DISCUSSION

DR. N. SPROAT HEANEY: I know that we have all found much to interest us in Dr. Kreuscher's paper. He has drawn attention to the fact that there are other causes for backache besides diseases of the female genitalia and lays particular emphasis upon the rôle of abnormality of the sacro-iliac joint and other bones in the etiology of backache. I believe, however, that gynecologists get more patients with backache than do any other class of doctors, even the orthopedists.

I will not pass by lightly the intimation that retroversion of the uterus is not a frequent cause of backache. If surgeons who make this assertion would, preliminary to a corrective operation for a retroversion, try the effect of a pessary first and if the patient were not relieved by a properly fitting pessary, refuse to operate in such cases of retroversion, there would be fewer disappointed surgeons saying that retroversion never produces backache.

Gynecologists, particularly those who are also obstetricians, are well acquainted with sacro-iliac subluxation as a cause of backache in women, particularly pregnant women. It is surprising how little help the X-ray usually gives in the diagnosis of subluxation of the sacro-iliac joint. Even when this condition is present, a properly fitting sacro-iliac belt does not always give relief. Are we, however, justified in saying, as does Dr. Kreuscher about retroversion, that a sacro-iliac subluxation never causes backache because the therapy aimed at its relief is not effective? Backache may be caused by worry or anxiety, the same as a headache may be produced by these nervous phenomena. Fissures of the anus and endocervicitis may also produce backache. Dilatation of the ureter and of the kidney pelvis are occasionally found to explain backache.

Spastic constipation may produce backache. We gynecologists know that the causes of backache are manifold and that it is just as erroneous to think that a particular backache is due to a displacement of the uterus and exclude other possible causes as it would be to assume that every backache that a woman has is due to subluxation of the sacro-iliac joint.

In closing I wish most emphatically again to reiterate that retroversions of the uterus can produce backache and that if a backache is due to a retroversion, a proper corrective operation will relieve it.

DR. C. S. BACON: I understand that the subject under discussion is pain in the back and pelvis and not pain limited entirely to the back. I suppose we may also include the subject of pain in the vagina which was discussed very comprehensively and interestingly some months ago by a member of this Society. A neurotic pain may occur anywhere in the body.

The speaker did not refer to the pain that comes on frequently in the small of the back after or during an attack of influenza. I myself had experience with it in the first epidemic, and I have had several attacks of that kind since. Dr. Ryerson was called in consultation and thought that there must be a dislocation of the sacro-iliac joint and ordered a support which I wore with not much more relief than that from an old-fashioned hot iron. The pain disappeared after a time. I was not convinced that there was a dislocation. I remember seeing a patient in the Cook County Hospital who had sciatica. After a hypodermic injection of water into the lumbar muscles the man suddenly got up and ran down the ward.

Another factor in pain in the pelvis is the dislocation of the ovary. A displaced ovary is very frequently the cause of pain in the back. If the displacement can be corrected by orthopedic manipulation or perhaps by an operation such as Saenger proposed some 30 years ago, relief will be obtained.

Then there is another condition that I have found not at all infrequently. A woman has suffered with a great deal of pain in the back and pelvis and you find the uterus in good position, and the ovaries not displaced. By pressing on the pelvic floor you elicit very marked pain reflected over the branches of the sciatic nerve. There is such a thing as sciatic pain in the branches of the nerve. It is similar to

intercostal neuralgia. I agree with Dr. Heaney that there are many different causes of backache.

Dr. Henry Schmitz: If we could locate points of sensitiveness that would indicate the seat of the lesion in the pelvis, the problem of differential diagnosis would be greatly facilitated. Heat has pointed out definite areas of skin sensitiveness in disease of the pelvic organs. For instance, in ovarian disease the skin sensitiveness would be over the tenth thoracic segment, in diseases of the tubes over the eleventh and twelfth segments. Erosion and endocervicitis cause a sensitiveness in the third and fourth sacral segments. We have for many years observed these findings and find them a great aid in the differential diagnosis of low backache.

One condition was not mentioned which I think is often the cause of backache in elderly women – the so-called atrophic form of parametritis which may be responsible for some of the most severe backaches. Unfortunately very little can be done to relieve these women. Retroversion of the uterus may cause backache as Dr. Heaney pointed out. The best way to prove this is to replace the uterus and keep it in anteversion by a pessary. If the backache is due to such a displacement it should disappear after replacement. Another common cause of backaches which is frequently overlooked is the unilateral or bilateral backache due to a pathological condition of the kidney. If resort was had to routine cystoscopic and kidney examinations quite a number of patients could be helped. If all these means at the command of the gynecologist have been exhausted, the orthopedic surgeon may then be consulted to aid in the search for a cause.

Dr. J. B. DeLee: I have just a few points to bring out. One can often prognosticate whether a patient is going to have a backache after the delivery of her baby. If she belongs to the status hypoplasticus type she is likely to have backache. The mesoblastic tissues do not provide sufficient support and the strain of pregnancy proves too much. I would also like to suggest that during X-ray examination a little traction be put on the leg while the picture is being taken. You sometimes find that the separation is much more marked in that than in the normal position.

I think that Dr. Kreuscher is wrong when he says that the sacrum is a keystone. It is shaped like a keystone, but it fits into the pelvis in a manner just opposite to that shown in the pictures on the screen. The pelvic ligaments become softer during pregnancy and stretch during labor, and the backache is the result of the dislocation of the sacrum produced by the passing of the child, the mesoblastic structures being already below par. I have noticed that women of the dystrophic type are not so likely to have backache. I have also noticed that women delivered by cæsarean section rarely have backache. I have also noticed that the women delivered with forceps instead of being allowed to go on for hours and hours in the second stage are less likely to have a backache.

I am glad that Dr. Heaney and Dr. Schmitz emphasized that inflammation of the sacro-iliac joints is a cause of backache. It is too easy to say that the backache is the result of uterine displacement, and I am inclined to disagree with my colleague. I think that the vast majority of backaches in women are caused by conditions outside the pelvis.

Dr. R. A. Scott: I think that every man dreads to see a woman come into the office with backache because there are so many different causes for it. Recently a well-known urologist in speaking to me said that backache in women was due in a great majority of cases to ureteral obstruction. In a well organized gynecological clinic in Boston which I attended, the patients complaining of backache were first sent to the roentgen-ray department, which I think is a very good routine practice. I think Dr. Kreuscher in his paper has proved that very conclusively.

Dr. Philip H. Kreuscher (closing): I wish to thank the officers for giving me this invitation. I wish to thank the men for the discussion of the paper. How fortunate it is that we do not all wear the same colored glasses. If we all wore rose colored glasses everything would be rosy all the time. We see things through our own glasses. We naturally remember those cases which are cured or relieved by the things we do for them. We forget sometimes the cases that are not relieved by the things we do for them. That applies to me and to you. We do not believe that belts and corsets correct these deformities. I tried to show you that belts, corsets, and even immobilization in bed with a Goldthwaite belt around the pelvis do not cure them. There are certain other conditions that must be taken into consideration. This I tried to show by saying that we must correct the deformity if there is one, that we must try to correct the alinement of the sacrum. With all due respect to Dr. DeLee I contend that the sacrum is wider at the top than at the bottom. An examination of a skeleton pelvis should convince us that the sacrum is wedge shaped and the wide portion of this wedge is at the top.

Dr. Heaney spoke of the cancer backache. There are those no doubt as well as the fatigue backaches. The men who do much industrial surgery will tell you that very often their companies are forced to make a settlement in these cases of malignancy.

I am very much interested in what one of the doctors said about "trial therapeutics." I was never a great believer in any appliance or method, devised for the relief of a painful back, which did not have a common sense mechanical or physiological basis.

CORRESPONDENCE

THE BALDWIN OPERATION FOR THE FORMATION OF AN ARTIFICIAL VAGINA

To the Editor: The article under the above title by Judin of Russia, appearing in your April issue, contains a number of statements, some of which I have seen in other publications on the same subject, and every one of which it seems to me should be corrected.

1. In my description of the operation, and in all my subsequent descriptions, I advised the use of the lower end of the ileum for the formation of the new vagina, but stated that if for any reason that part of the bowel was not available the sigmoid could almost certainly be used instead. Before publishing my description I had examined the mesentery in many hundreds of cases, in which the abdomen had been opened for various reasons, and had always found it ample for the purpose in mind and in my own work since then I have had no trouble whatever in using that portion of bowel.

2. The length of bowel utilized is to be no more than enough to make a normal vagina. By using only that amount I have never had the slightest complaint of any leucorrhœal discharge. In Judin's article the X-ray pictures show that a large surplus of bowel was taken and necessarily there would be a more or less annoying mucous discharge, while with the proper amount there would be no more than the normal moisture.

3. The opening for the vagina should be made by a transverse incision at the proper point in the perineum, where a line of cleavage will be found so that the separation of bladder and rectum can be accomplished rapidly and with the utmost safety. The only difficulty I have ever encountered was in a case in which an attempt had been made at the formation of a vagina by making an opening and packing it with gauze. Naturally the expectation that the opening would persist failed but the result was a mass of scar tissue which rendered the operation very difficult, though fortunately there was no wounding of either bladder or rectum and the result was perfect.

4. The closure of each end of the resected bowel by purse-string requires a minimum of time and there is an absolute minimum of chance for infection, and it is infection which is naturally the only real danger in the operation.

5. Careful examination of the mesentery at the proposed point should be made so as to determine the blood supply, and usually the continuity of the intestinal canal can be restored by the ordinary lateral anastomosis, both ends having been previously closed by inversion and purse-string. A Murphy button can be used if haste is required, or if the end of the ileum attached to the cæcum is too short for lateral anastomosis.

6. A hole is torn in the mesentery at the center of the resected bowel through which is passed a strip of gauze, which strip being caught by a clamp enables the bowel to be pulled down to the perineum without laceration. The fingers of the operator can be used to assist its passage from above and then to close over the peritoneum at the bottom of the pelvis so as to leave a minimum of raw surface. This part of the technique being completed (usually with removal of the appendix) the abdominal incision is closed.

7. The bowel protruding at the perineum is then opened with scissors and the edges of the opening attached around to the adjacent skin by chromic catgut stitches. Each half of the bowel is then wiped out and lightly packed with iodoform gauze so as to secure pressure sufficient to obviate oozing and to maintain the full size of the passage. If there seems to be any necessity for drainage a little cigarette drain is passed upward behind the bowel, to be removed in 24 or 48 hours.

8. The gauze packing can be left in for several days and when removed each side of the loop can be washed out with a little stream of hot water with perhaps some mild antiseptic added, if this is indicated.

9. At the end of two weeks a clamp is applied to the septum between the two halves of bowel which is crushed, the clamp being allowed to remain in position until it cuts its way through. If the blades of the clamp are not long enough a second application can be made so that the septum is finally divided through its entire length and a single passage remains.

10. The mortality should be practically no greater than that of an ordinary intestinal resection, since the additional work necessary should not give rise to any hæmorrhage or shock. I have had but one death in my own work (5 per cent), and in that case I am quite certain there would have been no fatality had it not been that the patient and her husband were ignorant foreigners and I was not permitted to practice stomach lavage, stimulating enemas, or other means of relief. So far as I know no attempt has been made in this country to tabulate any statistics, but from numerous reports which have been made to me by individual surgeons the mortality here must be very much less than that reported from foreign sources by Judin. Possibly the difference is due to departure from the original technique.

11. With increasing experience with the operation I have seen no reason to change the technique originally described. I have studied the suggestions as to changes which have been made from time to time but all of them seem to be based on incomplete study of the conditions present.

A year or two ago Allen B. Kanavel, the well known surgeon of Chicago, in showing me a patient who was just ready to go home told me that he had himself made a careful study of the original technique and of all the suggestions as to changes and had decided to follow the operation as originally described. J. F. BALDWIN.

Columbus, Ohio, April 11, 1927.

OPERATIVE TREATMENT OF OBSTRUCTION DUE TO A GROWTH IN THE DESCENDING COLON—A CORRECTION

IN the article by Dr. Jan Schoemaker, on the "Operative Treatment of Obstruction Due to a Growth in the Descending Colon," appearing in the September issue, pages 359–363, we wish to make the following corrections:

Under the heading "Second Stage," fourth paragraph, third sentence should read: "The only fixation of the colon now is the transparent anterior layer of the mesocolon." In the same section, in the fifth paragraph, the fourth sentence should read: "In this way we produce a 5 millimeter sleeve of mucosa plus submucosa." THE EDITOR.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a suffi ient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

TROPICAL SURGERY AND SURGICAL PATHOLOGY. By Karuna K. Chatterji, F.R.C.S.I., Major I.T.F. Medical Corps. With a Foreword by Major-General Sir R. Havelock Charles, G.C.V.O., K.C.S.I., M.D., LL.D., M.CH., F.R.C.S.I., I.M.S. (Ret.). New York: William Wood & Company, 1927.

FUNDAMENTALS OF THE ART OF SURGERY. By John H. Watson, M.B.B.S. (Lond.), F.R.C.S. (Eng.). New York: Paul B. Hoeber, Inc., 1927.

MALARIAL PSYCHOSES AND NEUROSES; WITH CHAPTERS MEDICO-LEGAL, AND ON HISTORY, RACE DEGENERATION, ALCOHOL, AND SURGERY IN RELATION TO MALARIA. By William K. Anderson, M.D., F.R.F.P.S.(Glas.). New York: Oxford University Press, 1927.

DIRECTORY OF THE AMERICAN BOARD FOR OPHTHALMIC EXAMINATIONS. Vol. i. 1927.

A HANDBOOK OF DISEASES OF THE STOMACH. By Stanley Wyard, M.D., B.S., M.R.C.P. New York: Oxford University Press, 1927.

DIE CHIRURGISCHE BEHANDLUNG DER GEHIRNTUMOREN; EINE KLINISCHE STUDIE. By Dr. Herbert Olivecrona. With co-operation of Dr. E. Lysholm. Berlin: Julius Springer, 1927.

INTRACRANIAL TUMOURS AND SOME ERRORS IN THEIR DIAGNOSIS. By Sir James Purves-Stewart, K.C.M.G., C.B., M.D.(Edin.), F.R.C.P. New York: Oxford University Press, 1927.

SURGICAL ANATOMY OF THE HUMAN BODY. By John B. Deaver, M.D., Sc.D., LL.D., F.A.C.S. 2d ed. in three volumes revised and rearranged. Vol. iii. Philadelphia: P. Blakiston's & Son, 1927.

THE MEDICAL DEPARTMENT OF THE UNITED STATES ARMY IN THE WORLD WAR. Volume XI. Surgery. Part One—General Surgery, Orthopedic Surgery, Neurosurgery. Prepared under the direction of Maj. Gen. M. W. Ireland. Washington: Government Printing Office, 1927.

METHODS AND PROBLEMS OF MEDICAL EDUCATION. New York: The Rockefeller Foundation, 1927.

CITY HEALTH ADMINISTRATION. By Carl E. McCombs, M.D. New York: The Macmillan Company, 1927.

CYSTOSCOPY; A THEORETICAL AND PRACTICAL HANDBOOK CONTAINING CHAPTERS ON SEPARATE RENAL FUNCTION AND PYELOGRAPHY. By Jas. B. Macalpine, F.R.C.S. (Eng.). New York: William Wood and Company, 1927.

PRACTICAL LECTURES ON THE SPECIALTIES OF MEDICINE AND SURGERY. Delivered under the Auspices of The Medical Society of the County of Kings. Brooklyn, New York. Second series, 1924–1926. New York: Paul B. Hoeber, 1927.

PLANT AUTOGRAPHS AND THEIR REVELATIONS. By Sir Jagadis Chunder Bose, M.A., D.Sc., LL.D., F.R.S., C.S.I., C.I.E. New York: The Macmillan Company, 1927.

HERNIA AND HERNIOPLASTY. By Ernest M. Cowell, D.S.O., M.D., B.S. (Lond.), F.R.C.S. (Eng.). With an Introduction by Sir Arthur Keith, F.R.C.S., F.R.S. New York: Paul B. Hoeber, 1927.

PIONEER MEDICINE IN WESTERN PENNSYLVANIA. By Theodore Diller, M.D. With a Foreword by J. J. Buchanan, M.D. New York: Paul B. Hoeber, 1927.

DIE GESCHLECHTSKAELTE DER FRAU. (Eine Psychopathologie des weiblichen Liebeslebens.) By Dr. Wilhelm Stekel. 3d ed. rev. Berlin: Urban & Schwarzenberg, 1927.

BIOLOGIE UND PATHOLOGIE DES WEIBES; EIN HANDBUCH DER FRAUENHEILKUNDE UND GEBURTSHILFE. Joseph Halban and Ludwig Seitz. Lieferungen 34, 35, 36, 37. Berlin and Wien: Urban & Schwarzenberg, 1927.

INTERNATIONAL CLINICS; A QUARTERLY OF ILLUSTRATED CLINICAL LECTURES AND ESPECIALLY PREPARED ORIGINAL ARTICLES ON TREATMENT, MEDICINE, SURGERY, ETC. Edited by Henry W. Cattell, A.M., M.D. Vol. i, 1927. Philadelphia and London: J. B. Lippincott, 1927.

A POCKET GUIDE TO MEDICAL LIFE ASSURANCE. Compiled by Jehangir J. Cursetji, M.D., L.R.C.P., L.R.C.S. 2d ed. rev. Bombay: Times Press, 1927.

MORTALITY STATISTICS. 1924. Department of Commerce. Bureau of the Census. Twenty-fifth Annual Report. Washington: United States Government Printing Office, 1927.

LA PYÉLOSCOPIE. By F. Legueu, Bernard Fey, and Pierre Truchot. Paris: Norbert Moloine, 1927.

L'ANGINE DE POITRINE ET L'ANGINE ABDOMINALE. By D. Daniclopolu. Paris: Masson et Cie., 1927.

LA PRATIQUE CHIRURGICALE ILLUSTRÉE. Volume xi. Victor Pauchet. Paris: Gaston Doin & Cie., 1927.

ANGINA PECTORIS; THE ANATOMY, PHYSIOLOGY AND SURGICAL TREATMENT. By Walter B. Coffey, M.D., F.A.C.S., Philip King Brown, A.B., M.D., and John Davis Humber, B.S., M.D. 1st ed. New Orleans: A. J. Dickerson, 1927.

A TEXT-BOOK OF PSYCHIATRY FOR STUDENTS AND PRACTITIONERS. By D. K. Henderson, M.D. (Edin.), F.R.F.P.S. (Glas.) and R.D. Gillespie, M.D. (Glas.), D.P.M. New York: Oxford University Press, 1927.

PAVLI AEGINE-TAE MEDICI OPERA A IOANNE GVINTERIO ANDERNACO MEDICO EXERCITATISSImo, summiq; iudicij conuersa: & illustrata commentarijs.

Cum Indice.

Cautum est priuilegio Caroli Quinti Imperatoris, ne quis intra septem annos, & Francisci Galliarum Regis ne intra tres quisquam Typographus ædes impressum ædat: aut aliunde empta uendat: cuius pœna in diplomatis notata est.

Argentorati per Vuendelinum Rihelium
ANNO M. D. XLII.

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED BROWN, M.D., F.A.C.S., Omaha

THE COLLECTION OF THE PLEIADES (THE SEVEN STARS) BY PAULUS OF AEGINA

THE last of the great surgeons of the Byzantine period was Paulus of Aegina. With his passing the final spark of the old Greek culture and science was extinguished so far as it could be called Greek. The so-called Dark Ages were ushered in and culture in art and science passed on to the Arabians. Being the last of the great Greeks, Paulus' work was taken as the most modern compilation of the time. With the writings of Hippocrates and Galen it was translated into Arabic by Honëin Ben Ishak, also known as Joannitius and became the foundation upon which the superstructure of Arabian medicine and surgery was built. The medical portion was followed by Rhasis in his teachings and from its surgical portion, the sixth book, Albucasis laid the basis for his surgery which was to remain the authority until the appearance in the fourteenth century of the great work of Guy de Chauliac.

Notwithstanding the prominence of Paulus of Aegina as a surgeon, practically nothing is known of his life. Even the date of the period during which he lived is a matter of dispute. Some authorities place him as early as the fourth century and others as late as the seventh, with the majority believing that the later date is the more correct. His name establishes fairly well that he was born on the Island of Aegina, a little way from Athens. Concerning his education, again we are forced to guess, but considering his knowledge of the ideas of the ancients which meant access to their work, it is reasonable to believe that he was a product of the school of Alexandria. Regarding the remainder of his life, little is known except that he was evidently a man with a great reputation as a scholar especially among the Arabians by whom he was called "Alkawabeli" (The Obstetrician).

In spite of his great reputation, Paulus left little original work. He was, as his predecessors had been, a compiler. He drew largely from the writings of Hippocrates and Galen and the still more recent Oribasius. He refers to other later authors but does not mention them by name, so their identity is lost to us. He summarized his knowledge in the "Seven Books of Medicine" called by the Arabians "The Collection of the Pleiades." When printing came into general use, Paulus' work was one of the first printed in Greek, being published by Aldus in 1528. The Arabian manuscripts were better, however, and from these the work was translated into Latin separately by three great scholars—Albanus Torinus, Guinter of Andernach, and Janus Cornarius. The first edition of the Guinter translation was published in Paris (1532) and the one here illustrated at Strassburg (1542) being printed by Wendelin Rihelius.

Paul of Aegina was probably an itinerant surgeon and teacher. It is generally believed that after receiving his education at Alexandria, he wandered throughout the Orient, absorbing what he could and practicing where he might be. His seven books cover the entire subject of medicine as it was known in his day, the most interesting book to the surgeon being the sixth which he devotes to surgery, and, differing from many of the authors of his era, he pays great attention to operative surgery.

Paulus begins the surgery with the head, goes on to the eyes and gradually travels downward, and ends with fracture and ulcer of the foot. He thus covers the entire body. One finds that he operated upon many conditions—As a rhinologist he removed polypi, as an ophthalmologist he removed pterygium and in the mouth he not only extracted teeth but also performed tonsillotomy. In general surgery he operated upon hernia, opened empyema with the actual cautery, and in urology he removed stones by lithotomy. As a war surgeon he evidently had considerable experience in the removal of foreign bodies. In this manipulation he calls attention to the technique that Paré emphasized nine centuries later in the Brissot case: that in removing a foreign body the patient must be placed in the position in which he was when the foreign body entered. He devotes also considerable attention to fractures and dislocations. His directions for reduction and immobilization are quite clear. He makes use of traction by machines for reduction and splints for immobilization. He distinguished between struma of the anterior portion of the neck (goiter) and that of the lateral portions (adenitis). His operation for struma is most interesting. He says, "We also lift up the larger strumas transfixed with hooks and at the same time the excised portions are freed from the body which surrounds them on all sides, being constantly mindful that neither the arteries, which are called the carotids, nor the recurrent nerves are injured." This may be applied either to an adenectomy or a thyroidectomy but in either event it sounds rather modern.

REVIEWS OF NEW BOOKS

TEN lectures by English doctors, authorities on the health of the child have been published in a small volume.[1] These lectures were delivered under the auspices of the Institute of Hygiene of England and give an indication of the ever increasing stress placed on keeping the child well, correcting incipient deformities, and therefore building up a stronger race for the future.

The ten lectures cover the following subjects; the dental problem in relation to school children, the prevention of nervous affections in the young, diet in schools, disorders of digestion during school life; the incidence of infectious diseases in public schools; affections of the nose, throat, and ear; the eye troubles of school life; some disorders of the skin during school life; the value of sport and physical exercise; preventable deformities in childhood and adolescence.

Many of the problems dealt with are not strictly applicable to American life because the mode of life and food habits discussed are different.

The book is of particular value to physicians doing school work and particularly those in attendance at boarding schools. Most of the subject matter is given in an elementary manner and is meant for the layman. It refers more often to large groups of children in boarding schools and gives some good ideas of the responsibility involved by the school physician in not only looking after acute illnesses but safeguarding teeth, supervising exercises, watching diets, and generally overseeing everything which involves the health of the child.

It is a book any parent with a child of school age can read with profit. GERARD N. KROST.

IN a monograph[2] of a little over 200 pages Bauer covers the subject of fractures and dislocations quite completely, giving, however, much more space to the mechanism, symptoms, and pathology of these two divisions of surgery than the average practitioner will spend time to read. Possibly criticism of the practitioner of this country is uncalled for in that connection but the sincerely interested surgeon cannot help but wish that a deeper understanding of these divisions of the subject were better taught and understood. To paraphrase, one may say possibly *autres pays, autres moeurs.*

If we assume that the knowledge of the mechanism and pathology of fractures and dislocations is an essential in their treatment, we find this a helpful, instructive book. The illustrations are well selected and uniform, but are mostly reproductions of roentgenograms with the addition of several pathological specimens. From the standpoint of the busy practitioner, however, many of his important problems are scantily dealt with. Ankle fractures, for instance, are dismissed with one page of discussion. The surgeon will find the work an excellent compend of the latest German ideas on the subjects of fractures and dislocations.

KELLOGG SPEED.

LEVINE'S *Practical Otology*[3] is a most readable book. It is sure of a warm welcome from otologists, not only from its own merits, but also from the sympathetic foreword written by Dr. James McKernon. It is a volume of 380 pages and represents a compilation of lectures given by the author at the New York Post Graduate Medical School and Hospital. The subject is presented as fully and clearly as is necessary in a textbook. The practical application of tests are so stated that little difficulty should be met with in applying them. The paragraphs on treatment are excellent.

The chapter which we find ourself least in agreement with is the one in which vertigo is discussed. The author lays too much emphasis on the semicircular canals as the cause of these symptoms. It seems to us that he has overstated his case. What proof is there that vertigo in renal insufficiency is due to stimulation of the semicircular canals (page 143); or that in cardiovascular diseases it is due to insufficiency of the blood supply to the labyrinth (page 144)? The emphasis ought to be laid on the vestibular pathway and its connection and less on the peripheral end-organ. In the same chapter sea sickness is also considered. With our present knowledge no one will object in a textbook of this nature to the assigning of the causation of this malady to labyrinthine disturbances. But when the author, in order to strengthen this causation, states that the absence of sea sickness in infants is due to incomplete development of the equilibratory organ (page 147), meaning thereby (see preceding sentence) the vestibule and semicircular canals, one objects. If he means that the labyrinth is poorly developed at this age, it is not so. If he means that the higher associations of the vestibular part are not fully linked up, then he has a better ground to base an argument on.

The chapter on deaf mutism is worthy of consideration, not only by otologists, but by the general practitioner to whom, as a rule, the parents first bring these cases, and who is in close touch with them for years.

As has been stated above, the practical part of the work is its best. As an example one would call attention to the chapter on the simple mastoid operation. This textbook we have no hesitation to

[1] THE HEALTH OF THE CHILD OF SCHOOL AGE. By various authors with a foreword by Sir Thomas Oliver, M.A., M.D., F.R.C.P., LL.D., D.C.L. New York: Oxford University Press, 1927.

[2] FRAKTUREN UND LUXATIONEN; ein Kurzgefasstes Lehrbuch fuer Arzte und Studierende. By Dr. Med. K. H. Bauer. Berlin: Julius Springer, 1927.

[3] PRACTICAL OTOLOGY. By Morris Levine, M.D. Philadelphia: Lea & Febiger, 1927.

recommend to otologists and to students of medicine. The general practitioner will find it a handy volume to which he can refer for general information on symptomatology and treatment.

J. GORDON WILSON.

THE four lectures by Professor Faber included in *Lectures on Internal Medicine*[1] are of great interest to the internist. They were given during a visit to the United States in 1926; the last is the Harvey Lecture of that year. The pathogenesis of achylia gastrica, considered first, has hitherto been obscure. It is usually thought of as functional or neurological. The work outlined here is another example of the truth of the old saying "Die Methode ist alles." Faber injected the abdomen with 10 per cent formalin solution immediately after death, thus obtaining clear pathological pictures of the stomach. His conclusion from this study is that achylia gastrica is a result of disease of the gastric mucous membrane which is entirely analogous to toxic or infectious conditions in other parenchymatous organs. The recent success of liver feeding in the treatment of pernicious anæmia makes the next lecture on the intestinal origin of this disease particularly interesting. His essential thought is that the anæmia results from toxins, usually, but not necessarily derived from the intestine. How the demonstrated potency of a few grams of non-protein, non-vitamin liver extract fits into this theory is as yet difficult to understand. The third lecture analyzes glycosurias in an instructive way. The Harvey Lecture is an historical outline of medical therapy. It presents the epoch making changes of the last hundred years. Louis' overthrow of the ancient and universal practice of phlebotomy came as the result of his method of clinical investigation, still so necessary, i.e., proving a therapeutic procedure in the clinic as one would test a physiological principle in the laboratory by controlled repetition. This led to an age of therapeutic nihilism, which has finally given way to credulity again, because of the wealth of possibilities offered the clinician by the biological sciences. The lectures are instructive and stimulating; full of careful work, sound analysis, and elevating thought. PAUL STARR.

THE third edition of *The Manual of Gynecology* by John O. Polak,[2] of Brooklyn, is welcomed, first, because of the excellency of the previous editions, second because of several additional features appearing in this edition and finally because this work of some 400 pages presents the subject of gynecology in a manner that will appeal to the overtaxed student of medicine and should satisfy the demands of the instructor who believes with the reviewer that all that should be required of the student is a thorough understanding of fundamental principles as applied to the diagnosis and treatment of diseases of women—a text free from theoretical discussions and not overburdened with operative technique. More should not be required in a text. It is, indeed, heartening to find a textbook written for students, and students only, rather than one that attempts to fill the needs of the student and practitioner. The overcrowding of the curriculum in our schools will bring an increasing demand for just such tests as that presented by Dr. Polak. We congratulate the author and the publishers.

PALMER FINDLEY.

A MOST unique production and one that will serve a limited but useful purpose is Gray's *Synopsis of Gynæcology*.[3] The book contains outlines of the entire subject of gynecology. It is in no sense a text and is not intended as such. The subjects are presented in a concise, orderly manner, admirably suited to the needs of the student who is preparing for examination. As a means of rapidly reviewing the subject the work deserves the highest commendation. It might almost be said that there is not a superfluous word in the text and yet the subject matter is complete without undue stress upon nonessentials. To the young instructor, this little book will serve as a guide in the preparation of his lectures, and if he will profit by it he is not likely to stray from the beaten path.

The reviewer has taken occasion to submit these outlines to several general surgeons and general practitioners for the purpose of eliciting their opinions. The universal comment was that the work is admirably adapted to their needs as a ready reference.

PALMER FINDLEY.

WILLIAM KNOX IRWIN,[4] of London, has just completed his revised and enlarged second edition of *Urinary Surgery*, a handbook for the general practitioner. In a sense, the title is a misnomer. The book is really an excellent synopsis of modern urological principles.

The author has departed from the strictly regional arrangement of subject matter. The first chapter deals with the anatomy concerned in urology; and this is followed by a short but lucid discussion on the examination of the patient. The next seven chapters have to do with the chief symptoms of the urological patient, their cause and treatment. Such important and interesting subjects as incontinence of urine, pollakiuria, difficult micturition, retention of urine, urological pain, hæmaturia, and pyuria are clearly discussed. The chapter on senile prostatic enlargement should be read by every general practitioner; it embodies all the principles of diagnosis and treatment which urologists are constantly trying to teach. The last

[1] LECTURES ON INTERNAL MEDICINE (delivered in the United States, 1926) by Knud Faber, M.D. New York: Paul B. Hoeber, 1927.

[2] A MANUAL OF GYNECOLOGY. By John Osborn Polak, M.Sc., M.D., F.A.C.S. 3d ed. rev. Philadelphia: Lea & Febiger, 1927.

[3] A SYNOPSIS OF GYNÆCOLOGY. By Arthur Gray, F.R.C.S., M.R.C.P. New York: Longmans, Green & Co., 1925.

[4] URINARY SURGERY; A HANDBOOK FOR THE GENERAL PRACTITIONER. By William Knox Irwin, M.D., F.R.C.S.E. 2d ed. rev. and enlarged. New York: William Wood and Company, 1927.

fifty pages of the book are devoted to operations on kidneys, ureters, bladder urethra, prostate and penis; there is no attempt at detailed descriptions, but the subject matter is adequate.

This book is recommended for perusal especially by the general practitioner; the concepts of pathology and the principles of treatment will serve as a great aid in handling urological problems.

HARRY CULVER.

A LARGE single volume[1] covering the field of internal medicine, including nervous and mental diseases has been written by one hundred and thirty American physicians, most of whom are actively engaged in advancing clinical knowledge of the subject upon which they write. The articles, therefore, have a quality of simplicity and reliability which is most refreshing. Furthermore, one may read on almost any subject with the feeling that he is getting special knowledge rather than the more general and superficial opinion of some one writing second hand as is sometimes true in the single author works. Treatment is well emphasized and includes the most recent discoveries. Several leading references are given with each article, making it a starting point for more extended study. This should be a popular students' text and attractive to physicians and surgeons because of the authority behind the writings. PAUL STARR.

PROFESSOR PORTMANN and Dr. Retrouvry[2] have given us a very full description of cancer of the nose, its prognosis and treatment in a volume which is one of a series now being published in France on cancer in various parts of the body. This particular part will appeal not only to specialists but to the general surgeon.

In the work under review each region of the nose is considered separately. The pathological anatomy together with the predisposing causes are discussed with sufficient detail. The various methods of treatment are fully and critically considered and the statistical data given lend emphasis to the deductions drawn. The paragraphs on treatment are a noteworthy feature of the work.

The chapters on cancer of the maxillary sinus and of the nasopharynx call for special notice because of the clearness and fullness with which the subject is treated. In the former the writers consider neoplasms in this area in three stages: First, the latent period when the growth is within the sinus; second, the period of deformation due to the growth and external pressure; and third, the period of invasion of the surrounding tissues. This method of attack gives the authors an admirable means of discussing differential diagnosis and treatment. It is during the latent period that the rhinologist has the greatest difficulties in his diagnosis and these difficulties are fully appreciated by the authors.

The chapter on cancer of the nose treats the pathological conditions of clinically benign lesions which may under diverse influences tend to become cancerous, such as nævi, cystomata, cysts, keloids, and cicatrices of burns and lupus. The different methods of treatment occupy a large part of each section. The relative merits of diathermy and radium are very well stated; especially noteworthy is the chapter attached to cancer of the nasopharynx.

The clearness with which the whole subject is treated is typically French. This with the details furnished makes the treatise well suited as a work of reference. J. GORDON WILSON.

IN the wake of the war has come the spread of "sports" over Europe. So enthusiastically have our Gallic cousins taken them up that their surgeons now see numerous instances of disturbance of the semilunar cartilages of the knee joint, as a result of which a delightful, orderly monograph[3] appears.

The work is based on a report made by the authors before the thirty-fifth French Surgical Congress and although entitled Pathology of the Menisci of the Knee, it deals completely with the subject from a clinical standpoint, including treatment both nonoperative and operative. Both the traumatic and pathological alterations, including cysts and prendocysts of the cartilage, are covered.

The illustrations are simple line drawings which are easily understood. A commendable feature is the few pages given to interpretation of roentgenograms of the knee. Arthroscopy is dismissed at about its true value. A good bibliography is attached.

This book is a concise reference for the surgeon dealing with these injuries. KELLOGG SPEED.

I FIRST became acquainted with Bing's *Compendium*[4] as a student; probably because it belonged to that group of compendia which included surgery and medicine and were the objects of derision from our instructors. The latter obviously went in for large and weighty volumes and often the owners of these "compends" were the recipients of spiritual and material punishment. This particular compendium was popular because in it clinical neurology was shorn of its Mephistophelian disguise and was shown to be the offspring of parents, both of whom we had met before: neuroanatomy and neurophysiology.

In a way neurologists are to blame for the spirit of hopelessness which students and practitioners

[1] A TEXT-BOOK OF MEDICINE BY AMERICAN AUTHORS. Edited by Russell L. Cecil, A.B., M.D. Associate Editor for Diseases of the Nervous System, Foster Kennedy, M.D., F.R.S.E. Philadelphia and London: W. B. Saunders Company, 1927.

[2] BIBLIOTHÈQUE DU CANCER; LE CANCER DU NEZ, DES FOSSES NASALES, DES CAVITÉS ACCESSOIRES, ET DU NASO-PHARYNX. By Georges Portmann and Henri Retrouvry. Paris: Gaston Doin & Cie, 1927.

[3] PATHOLOGIE DES MÉNISQUES DU GENOU. By Albert Mouchet and Louis Tavernier. Paris: Masson et Cie, 1927.

[4] COMPENDIUM OF REGIONAL DIAGNOSIS IN AFFECTIONS OF THE BRAIN AND SPINAL CORD; A CONCISE INTRODUCTION TO THE PRINCIPLES OF CLINICAL LOCALIZATION IN DISEASES AND INJURIES OF THE CENTRAL NERVOUS SYSTEM. By Robert Bing. Translated from the Sixth German edition by F. S. Arnold, B.A., M.B., B.Ch. (Oxon.). 3d ed. rev. and enlarged. St. Louis: The C. V. Mosby Company, 1927.

exhibit toward their chosen field. Few of them who write are able to do so clearly and simply. It is as if they made their subject appear more difficult to strengthen their own defensive mechanisms. At any rate the third edition of the translation from the sixth German edition testifies to the popularity of this book among those of us who must get our knowledge in simple and accurate terms.

LOYA DAVIS.

A SMALL monograph[1] is presented which records the personal observations of a well-known English neurologist upon 117 verified intracranial tumors. The major number of the verifications were made by autopsy. This may be a challenge to those interested in neurological surgery in England. Nothing is added to our present knowledge of facts in the diagnosis of intracranial tumors; but a frank record of errors in diagnosis and in steps taken to make a diagnosis are set forth. These are enlightening. LOYAL DAVIS.

OF the increased number of publications on X-ray diagnosis, Redding's *Manual*[2] is one of the best that has appeared. It will prove helpful to the X-ray worker who has not the advantage of the great volume of work found in large medical centers. The text is conservative and well written, indicating that the author is exceedingly well versed in the subject. The illustrations of the various lesions described in the text are in the main of excellent quality. EDW. S. BLAINE.

AN elementary handbook adapted more especially for the surgeon who desires to have a working knowledge of roentgenology applicable to his specialty has been prepared by Hans Kurtzahn.[3] He discusses briefly modern apparatus, technique, indications for diagnostic use, and the findings characteristic of lesions commonly encountered in surgical practice. The part devoted to roentgen therapy is covered particularly well as regards technical considerations, but surgical prejudice seems apparent in the discussion of its field of usefulness. Thus the statement is made that radiotherapy with rare exceptions is applicable only in inoperable cases of malignancy. Its usefulness in conditions such as carcinoma of the cervix and uterus is not even mentioned. Its value in glandular tuberculosis, actinomycosis, exophthalmic goiter, and various other more or less benign conditions, is given due consideration. A short appendix is included giving only the rudiments of the application of radium therapy. ADOLPH HARTUNG.

[1] INTRACRANIAL TUMORS AND SOME ERRORS IN THEIR DIAGNOSIS. Sir James Purves-Stewart, K.C.M.G., C.B., M.D.(Edin.), F.R.C.P. New York: Oxford University Press, 1927.

[2] X-RAY DIAGNOSIS; A MANUAL FOR SURGEONS, PRACTITIONERS, AND STUDENTS. By J. Magnus Redding, F.R.C.S., Senior Surgical Radiologist, Guy's Hospital, London. New York: Wm. Wood and Company, 1927.

[3] CHIRURGISCHE ROENTGENOLOGIE; EIN GRUNDRISZ DER ANWENDUNG DER RONTGENSTRAHLEN IN DER CHIRURGIE MIT EINEM ANHAND RADIUMTHERAPIE. By Hans Kurtzahn. With a foreword by Prof. Dr. M. Kirschner. Berlin and Vienna: Urban and Schwarzenberg, 1927.

THE ninth volume of the *Bibliothèque du Cancer*[4] edited by Hartmann and Bérard has appeared. The authors have in these 424 pages presented a full discussion of malignant tumors of bone. After a general introduction to the subject, 15 pages are devoted to a discussion of etiology. Their views on the relation of trauma to sarcoma of bone are conservative and are apparently based on the work of Segund.

One hundred and fifty pages are given to the discussion of the pathological anatomy and classification of malignant tumors of bone. They consider 5 general types: osteosarcoma, giant cell tumors, multiple myeloma, endothelioma, and metastatic tumors. Their classification of osteosarcomata is somewhat more involved than that to which American readers are accustomed inasmuch as they classify them, first, as to their macroscopic appearance into encephaloid, fascicular, osteoid, telangiectatic, and cystic sarcoma; second, as to their relation to the bone into central and periosteal sarcoma; and third, as to their histopathology into spindle and round cell sarcoma. Under the discussion of giant cell tumors of bone a special section is devoted to giant cell tumors of the maxillæ.

Following the chapter on pathological anatomy is one on the symptomatology of the different types of malignant tumors of bone. The symptoms of each of the five bone groups are discussed in three divisions: The symptoms of the early stages, after full development, and in the terminal stages. The authors do not believe that the radiographic signs of sarcoma of bone are specific "because, as in all other affections of bones, there result destruction and alterations of bone substance by the neoplasm, and by defense reactions which are found around these lesions." The symptoms of osteosarcoma and of each of the other types are taken up. The discussion of the diagnosis of sarcoma of bone extends through 64 pages. The first section of this chapter is devoted to general considerations. The authors are opposed to biopsy as a means of diagnosis on account of the danger of facilitating the formation of metastases. In the second section of this chapter is a full and clear discussion of the differential diagnosis between bone sarcoma and parosteal tumors, aneurysms, ossifying hæmatomata, osteomyelitis, syphilitic and tuberculous osteitis, hypertrophic callus, osteitis fibrosa, and various benign tumors of bone. This is followed by a discussion of the differential diagnosis of the various types of sarcoma of bone. The final chapter of 69 pages is devoted to treatment.

The volume is illustrated by 48 plates containing from one to four illustrations in black and white. These include gross, microscopic, and roentgenological appearances of bone tumors. In many instances the same plate contains the X-ray, gross, and microscopic appearance of the same tumor. The histopathology is shown by means of photomicro-

[4] BIBLIOTHÈQUE DU CANCER: TUMEURS MALIGNES DES OS. By G. Nové-Josserand and L. Tavernier. Paris: Gaston Doin et Cie, 1927.

graphs which, on the whole, are clear and well selected. On the page facing each plate is a full description with clinical and other details concerning each illustration on that plate.

In the bibliography are the names of the authors arranged alphabetically and the full titles of the articles. References to American literature on tumors of the bone are fairly numerous. The latest reference is to publications in 1925 of which there are three. Relatively slight attention is given to the results of the registry of cases of bone sarcoma formerly under the management of Dr. Codman, and now carried on by the American College of Surgeons. The book can be cordially recommended as a clear statement of facts concerning malignant tumors of bone written in a pleasing and easily read French. The typography is excellent, the print being large with wide spaces between the lines.

J. P. SIMONDS.

VOLUMES I and II of Deaver's *Anatomy*[1] have been reviewed in earlier numbers of this journal. The present and final volume continues the high standard already established. Its contents include the joints of the lower extremities, the chest, thorax, abdomen, pelvis, and perineum. This is probably the most interesting and instructive of the three volumes to the average surgeon. The present arrangement is considerably improved over that formerly used. Both author and publisher deserve the highest praise for the production of so beautiful and authoritative a work; it well deserves to continue as the standard source of information on surgical anatomy.

L. B. A.

TO those who have witnessed the development of the slit-lamp by Gullstrand, Henker, and Vogt, there can be no doubt but that it has added much and will add more to our knowledge of ocular pathology. The extravagant claims of the enthusiast will be toned down and the reticence of the doubting will be brushed aside when the balance is finally struck. As the author of the admirable guide to the use of the slit-lamp[2] states, the magnification is not so important as the improved illumination, for as he admits, much that can be seen with the microscope can be made out with the loupe and even the naked eye. With that calm statement of an essential fact one looks farther through Butler's book for much sound advice and is not disappointed except in the discussion of sympathetic ophthalmia. It is impossible to agree with him concerning the part the slit-lamp may play in deciding the question of enucleation. If the sympathetic type shares with other types of uveitis the sign of cells in the aqueous, retrolental space and vitreous, why make their presence the deciding factor in favor of removal of the injured eye? Patients with injured eyes have had a coincident bilateral iritis due to focal infection following trauma to one eye. Why ignore the possibility of coincident focal infection, not excluding lues and tuberculosis which give the same symptoms? Shall the possibility of bilateral blindness be determined by the presence or absence of a few cells as seen with a binocular miscroscope and a well directed beam of light? The older ophthalmic clinicians have not all died as yet and those who have may well arise to help the old guard fight against such teaching.

The book is well printed and consists of 144 pages divided into 16 chapters, with a good index and 158 illustrations and 5 color plates. Perhaps those who already know a great deal about the slit-lamp will find only confirmation of their ideas in this volume, but to the beginner it should be a great help.

V. WESCOTT.

[1] SURGICAL ANATOMY OF THE HUMAN BODY. By John B. Deaver, M.D., Sc.D., LL.D., F.A.C.S. 2d ed in three volumes thoroughly revised and rearranged. Vol. iii. Philadelphia: P. Blakiston's & Son, 1927.

[2] AN ILLUSTRATED GUIDE TO THE SLIT-LAMP. By T. Harrison Butler, M.A., D.M. (Oxon.), M.R.C.S. (Eng.), L.R.C.P. (Lond.). New York: Oxford University Press, 1927.